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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN.

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NOTES AND COMMENTS.

The Elimination of Non-Metallic Inclusions.

At the last meeting of the Newcastle Branch of the Institution of British Foundrymen, Mr. Hurst conclusively established that cast iron which has been centrifugally cast possesses a higher maximum tensile strength than either sand-moulded or chill-cast material of similar analysis.

Amongst the explanations which can be put forward are, smaller grain size, the removal to the inner edge of the casting of the sulphide segregations, the total expulsion of slag inclusions, pressure and agitation. The reasonableness of the first three explanations is beyond question, but the fourth, if a comparison with steel cast under pressure is permissible, cannot be substantiated.

Agitation can only be beneficial when conducted in such a manner as to effect the removal of slag and non-metallic inclusions. Whilst this is accomplished during the centrifugal manufacture of iron castings, we are doubtful whether a system of jogging or jarring chilled castings or ingots would have any good effect. Lord Chetwynd's process brings about somewhat analogous results, though by the application of totally different conditions. The Chetwynd process consists in applying electric current to molten steel contained in a modified steel ladle for a short period. This treatment seriously decreases the quantity of non-metallic inclusions and gas in the finished state. Though these two processes are diametrically opposed as to application, there is a distinct correlation, as both processes utilise the low specific gravity of slag and other impurities for their elimination. That this factor is the outstanding feature in both processes would probably be contested, but it is in itself so important that it may possibly be the fundamental principle for the production of superior physical tests in iron and steel, making grainsize, gases and other factors merely contributory.

Cleaning Castings

The iron foundry has been described as being the Cinderella of ferrous metallurgy. This being so, the fettling department could be justifiably designated as its "ugly sister," as it only too often consists of a shed surrounded by a collection of rusty, unwanted castings and derelict patterns. We are fortunate this week in being able to print a lecture on this subject, and hope that it will stimulate some of the members of the Institution of British Foundrymen to come forward with papers on this important subject. It was recently stated by a travelled metallurgist that the great difference between American and British foundries was the large amount of floor space and the special attention devoted to the dressing of the castings. Health considerations alone should be sufficient to warrant the closest attention being given to the fettling department by all foundrymen.

The Relationship of Metallurgical Processes.

In this age of specialisation the revision of the principles underlying the processes allied to those with which we are daily occupied acts as a tonic. Many modern inventions are the result of such elementary investigations. A recent example of this is the protection of the use of the Bessemer process for the production of the valuable low-carbon ferro-chrome from the comparatively cheap high-carbon ferrochrome by the oxidation of carbon pneumatically. We would commend to our readers a perusal of Mr. Sellar's paper on "The Making of Iron and Steel" which appears on page 250 of this issue of THE FOUNDRY TRADE JOURNAL, where a rapid review is made of the chemistry of all the more important methods.

Once the chemistry of the elmination of impurities from iron ore, pig-iron or steel is thoroughly mastered by the student, his daily work becomes more interesting, and the application of such knowledge is bound to reflect upon the quality, if not the quantity, of the material studied.

The British Cast-Iron Research Association.

Meetings have been held by the Council at Newcastle, Derby and Manchester to meet the Foundry Employers' Federations in these districts to discuss the details of the Research Association. The meetings have been largely attended, and the unanimous support promised to the Council has placed success beyond doubt. The Council will be glad to arrange for the Secretary to visit any district to address a meeting of foundry proprietors if a request is made to the Association.

XUM

Institute of Metals.

At the thirteenth annual general meeting of the Institute of Metals, held on March 9, a number of Papers dealing with non-ferrous metals, etc., were submitted.

According to the report of the Council for the year ended December 31, 1920, notwithstanding the raising of the ordinary members' annual subscription from £2 2s. to £3 3s., the membership of the Institute has increased during the year from 1,213 to 1,298. In consequence of this increase in the annual subscription it has been possible to continue the work of the Institute unimpaired, but the margin between income and expenditure is still so small that all expenditure has to be watched closely. The Council have co-operated during the year with the Conjoint Board of Scientific Societies, with the object of approaching the Government with a view to obtaining a grant.

The number of honorary corresponding members to the Council is now twelve. The number of members on the roll of the Institute on December 31, 1920, was as follows:—Honorary members, 3; ordinary members, 1,214; student members, 81; total, 1,298.

The Fifth Corrosion Report was published at the March meeting of the Institute. During the remainder of the year the work of the Committee has been directed along two main lines—namely, the determination of the effect on the corrosion of tubes of various factors connected with the design and arrangement of condensers (such as the variations in water speed, angle of tilt of tubes, arrangement of baffle plates and protector blocks), and the devising and testing of various methods of protecting tubes, particularly from the action of chloride waters. Of the methods so far investigated that of lining tubes internally with lead has given very good results, and arrangements have been made to give the process an extended trial on a full work scale. During the latter part of the year the Committee's work has been extended at the request of the Research Department of the Air Ministry to cover the investigation of the corrosion of light aluminium alloys by sea and fresh water and atmospheric conditions. A special sub-committee has been set up to organise and superintend this work. Control of the atmospheric corrosion has been transferred, at the request of the Research Department, to the British Non-Ferrous Metals Research Association.

As regards the Beilby prize research, the work on the solidification of metals has been continued during the past year with some interruption, owing to the transfer from Glasgow to Sheffield, and it is hoped to present a further report at the autumn meeting of the Institute. Mr. A. T. Roberts has been engaged on the examination of crystal grains in metals, and has made a number of interesting observations. In this connection advantage is being taken of the equipment of the University of Sheffield for preparing ingots to obtain coarse structures by the slow cooling of pure metals and of solid solutions. The macrographic and micrographic examination of these slowly cooled ingots is proving a useful means of research in dealing with crystallisation. Further experiments are also in progress relating to the influence of surface tension on metals at high temperatures. These experiments were begun in Glasgow, but have been interrupted for a considerable time.

According to the report of the Hon. Treasurer, the subscriptions, including entrance fees, have amounted to £2,892, as against £2,353 in 1918-19. Taken altogether the expenses of 1919-20 amounted to £3,620, with a gross income of £4,174. The balance-sheet shows £375 in the bank.

The following are brief summaries of the Papers presented at the meeting:—

THE SEASON CRACKING OF BRASS AND OTHER COPPER ALLOYS.

By H. Moore, S. Beckinsale and Clarice E. Mallinson.

Numerous specimens of brass in which season-cracking has occurred have been examined, and an investigation made of the causes of season-cracking, the detection of liability to fail in this way, the mechanism of the process by which the cracks form and develop, the effects of variations in composition, structure and physical properties such as hardness and the prevention of season-cracking. Among the more important conclusions are the following:—Season-cracking occurs in a great variety of industrial brasses, differing widely in composition, degree of purity, microstructure, and physical properties, but occurs only in material which is maintained in a state of stress, either by external constraint or more commonly by internal stress. Corrosion of the surface and sometimes of the walls of the cracks is frequently associated with season-cracking, but corrosion effects are not always visible. Season-cracking may occur in brass coated with continuous protective layers such as lacquer, though nickel-plating is probably completely effective in preventing cracking, if a sufficient and continuous coat of nickel is secured. Highly-stressed articles, capable of developing season-cracks in certain conditions, may be kept for years in reasonably pure atmospheres without showing any sign of cracking, and there appears to be no reason to anticipate the development of cracks so long as the condition of the surrounding atmosphere does not change. Some agency additional to the presence of initial stress appears to be necessary for the development of cracks. Surface defects do not appear to contribute to the development of cracks in brass to any important extent, and corrosion does not necessarily favour their development. Mercury, ammonia and ammonium salts readily produce cracks in brass which is sufficiently stressed in tension.

Season-cracks almost invariably follow an intercrystalline path, and the cracks produced in stressed brass by mercury or ammonia are of the same intercrystalline type. Ammonia appears to have a specific and selective action upon the intercrystalline material of brass, weakening it sufficiently to cause cracking if in tension. Mercury has a similar intercrystalline weakening action. The greater the degree of hardening by cold work the less is the brass affected by the intercrystalline weakening action of ammonia or mercury. It is probable that the behaviour of a copper alloy submitted to the combined effect of tension and of ammonia or mercury is a reliable index of its liability to fail by season-cracking. This liability appears to diminish as the zinc content of the brass is reduced. Copper and zinc-copper alloys containing less than about 10 per cent. of zinc are unlikely to fail by the development of season-crack in service.

A suitably controlled low temperature annealing which will remove stress sufficiently to ensure freedom from season-cracking with little or no effect on the hardness appears to be the most effective safeguard against failure by season-cracking, and might well be applied to all brass articles made by cold-work operations capable of inducing permanent internal stress.

SOME NOTES ON CALCIUM.

By P. H. Brace (East Pittsburgh, Pa., U.S.A.).

This Paper gives a brief historical survey of the development of the metallurgy of calcium, and describes a type of apparatus developed by the writer for the manufacture of the metal, which is obtained by the electrolysis of fused calcium chloride. A summary of the more important uses of calcium, including the preparation of certain aluminium alloys, is given in the Paper

PLASTIC DEFORMATION OF SOME COPPER ALLOYS AT ELEVATED TEMPERATURES.

By Professor C. A. Edwards and A. M. Herbert.

The object of the investigation was to determine the plasticity of certain copper-aluminium and copper-zinc alloys at temperatures between 0 and 900 deg. C. In most, if not all, previous investigations the observations have been made by one of the well-known methods of testing under static loads. In the present work dynamic stresses have been applied by means of a falling weight to which was attached a 10 mm. steel ball. The degree of plasticity was calculated from the size of the indentations produced in the specimens by the ball. The results obtained give unmistakable indications of pronounced changes in the plasticity of both series of alloys at temperatures which correspond with structural transformations that are known to occur in the respective series. It may seem rather curious that the same kind of evidence does not seem to be obtained when a static method of testing is used, but such appears to be the fact. It is to be remembered that in most commercial operations, such as forging, hammering, rolling and extrusion, the stresses are applied at phenomenally rapid rates. Hence plasticity determinations under dynamic stresses are much more likely to give data that are comparable with the above-mentioned practical operations than those from static tests.

THE ACTION OF REDUCING GASES ON HEATED COPPER.

By H. Moore and S. Beckinsale.

Specimens of copper containing different percentages of oxygen, together with specimens completely deoxidised and containing a small excess of zinc, manganese, aluminium or phosphorus, were exposed to

the action of different reducing gases at different temperatures and for varying lengths of time. A markedly injurious effect is produced even when the oxygen content of the copper does not exceed 0.026 per cent. In copper containing 0.07 per cent. oxygen the effect of reducing gases begins to be important at about 600 deg. C. The lower the oxygen content the higher is the temperature required to cause similar injury. The higher the temperature or the longer the time of action of the reducing gases at any given temperature, the more deeply does the effect penetrate. Coal gas is intermediate between hydrogen and carbon monoxide as regards depth of penetration in a given time, but its actual weakening effect seems to be greater than that of either of these gases.

Copper containing a small percentage of zinc, manganese, aluminium or phosphorus is entirely free from globules of cuprous oxide, and is not affected injuriously when heated in reducing atmospheres. Copper prepared in this way is completely immune from injury even under the most severe conditions, say, six hours at 1,000 deg. C. in a current of coal gas. Copper completely deoxidised with hydrogen when molten is equally immune from the injurious effect of reducing gases. For some purposes, other than electrical, an alloy of copper with 3 per cent. of zinc appears to be a better material than commercially pure copper. The presence of 2.5 to 3 per cent. of zinc in the copper confers useful properties in addition to the immunity from injury resulting from heating in reducing atmospheres, which is secured even with 0.1 per cent. of zinc.

STAGES IN THE RE-CRYSTALLISATION OF ALUMINIUM SHEET ON HEATING.

By PROFESSOR H. C. H. CARPENTER and CONSTANCE F. ELAM.

The Paper is closely connected with that presented by the authors at the previous meeting of the Institute on "Crystal Growth and Re-crystallisation in Metals." The investigation has been designed to throw as much light as possible on the structural changes which accompany the gradual softening of cold-rolled aluminium sheet on heating. Statements have been made by two previous investigators, Brislee and Anderson, that aluminium loses its crystalline structure on working and becomes completely amorphous. The present authors show that this statement is incorrect; even in the cold-rolled sheet the crystals, though very much flattened and to some extent driven into one another, retain their identity.

In a Note (appended to the Paper) on "The Birth of Crystals in Strained Metals and Alloys," the authors furnish further examples of the fact that re-crystallisation is always observed to begin in the boundaries of the distorted crystals, using the term "boundaries" in the broad sense to include twin boundaries. The only instances in which the new crystals were formed in the interiors of the old crystals were those in which they originated at a segregated impurity, and here also there was a boundary, although of a different kind.

THE CONSTITUTION OF THE ALLOYS OF COPPER WITH TIN.

By J. L. HAUGHTON.

This Paper describes the constitution of the copper-tin alloys containing from 40 to 100 per cent. of tin below a temperature of 400 deg. C. The constitution was investigated by means of thermal curves, electrical conductivity measurements and microscopic examination of annealed and quenched specimens. It has been shown that there is a polymorphic transformation in one of the constituents at a temperature of about 180 deg. C., and in a few of the alloys a further transformation occurs at 210 deg. C., which so far cannot be explained. The limits of solubility of tin in copper have also been investigated, and it is found that not more than 0.2 per cent. of copper dissolves in solid tin.

STEEL CASTINGS AND THE IRONFOUNDRY.—In a recent issue of "The Blast Furnace and Steel Plant," Mr. G. P. Fisher states:—Many plants operating an iron foundry have a demand for steel castings. Where this demand is intermittent and not for a large tonnage, the side-blown converter is the ideal installation. The melting equipment for the grey-iron foundry and for the converter steel foundry is the cupola, already installed. When steel is required the metal can be melted in the same cupola ahead of the grey-iron mixture. Where small tonnage is required the initial investment is worthy of serious consideration. The converter can be installed and put into operation for approximately one-sixth the cost of the electric furnace and from one-half to one-third the cost of open hearth.

Rotating Heat-Treatment Furnaces.*

The straight line continuous furnace has, without any doubt, the great advantage of moving the material through the shop in a logical manner, maintaining a constant direction of travel, but it also has the disadvantage that irregular shapes

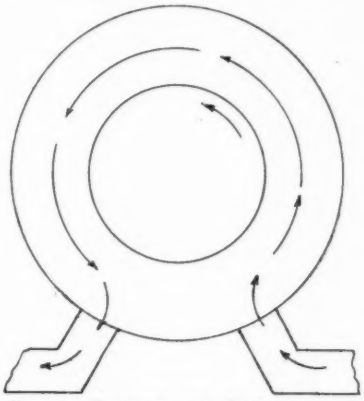


FIG. 1.—SHOWING THE PRINCIPLE OF ROTATING-HEARTH FURNACES.

cannot be moved through it except on cars, or in trays, which, of course, means heat losses and the inconvenience of bringing the cars or trays back again to the charging end. The rotating hearth, a plan view of which, together with

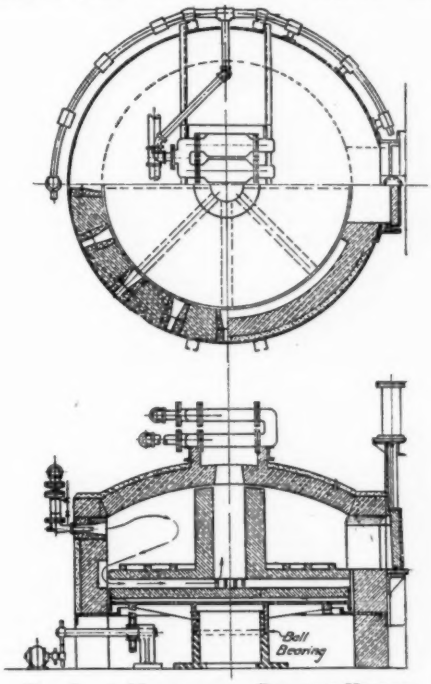


FIG. 2.—A MEDIUM-SIZED ROTATING-HEARTH FURNACE.

approach and delivery tables, is shown diagrammatically in Fig. 1, avoids much of this trouble. The material can still be made to travel through the shop in a straight line, except that there is a big loop in that line, wherever the furnace is located. This arrangement causes no trouble except where several sets of materials are moving through the shop in parallel lines. In that case, the round furnace is liable to result in waste space, unless the furnaces can be staggered.

In all other respects the round furnace is advantageous The material which is to be heated is placed on the hot hearth and is carried around on it. There is no pusher, there are no hearth bars, no cold spots in the hearth; there is no buckling of the material or piling of the pieces on top of each other.

* Extracted from an article by W. Truks which recently appeared in the Blast Furnace and Steel Plant.

Fig. 2 shows a rotating hearth furnace of medium dimensions designed by the General Combustion Company; whilst Fig. 3 illustrates a fairly large rotating-hearth furnace of the Tate-Jones type. When the furnaces shown in this latter illustration were under construction, almost everyone predicted failure, because large rotating hearths "had always given trouble." In spite of these prophecies, the furnaces are in excellent operation. In the design and in the erection of large rotating-hearth furnaces some precautions must, of course, be used, which had heretofore been overlooked, because furnace builders have been bricklayers rather than mechanical engineers.

In the furnace of Fig. 3 it is extremely important that the hearth rests evenly on the rollers, not only when cold, but much more so when hot. To that end, the pit under the furnace must not only be accessible, but must be kept cool enough to permit an occasional brief inspection of the wheel contact. The wheels must be individually adjustable in up and down direction (not shown in the drawing)

In order to comply with the requirements both of accessibility and of reasonably low temperatures, the pit is made deep enough for a man to walk through in a stooped position, and entrance shafts, covered with a grating, are provided. These same shafts serve as inlets for the circulating air which is led to the bottom of the stack by four narrow ducts. The area of the latter can be adjusted by means of a loose brick.

The horizontal thrust caused by the main gear drive is taken up by separate rollers (not shown) bearing against the track. The seal between the heating chamber and the pit is effected by silocel powder instead of sand, because it was found to offer less resistance to motion. The seal chambers

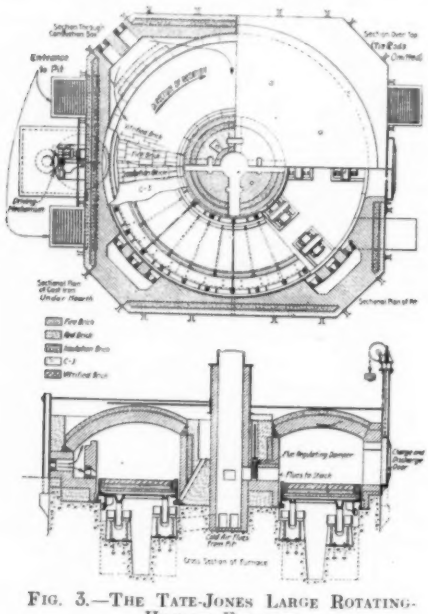


Fig. 3.—The Tate-Jones Large Rotating-Hearth Furnace.

have flap doors through which the sealing material can be removed at regular intervals. This is necessary, because scale drops in between the hearth and the sidewalls.

Uniformity of temperature is obtained by guiding the products of combustion in distributed directions. From the upper left-hand end of the illustration it is seen that, on account of the bridge-walls being lower at the sides than in the centre, the flame is directed along the outer walls, as indicated by the arrows, and then passes downward and across the hearth into the flues. Another part of the products of combustion, as indicated in the left-hand bottom end of the illustration, is directed along the hearth and passes under the carbonising pots, which rest on stools. If the material to be heated is laid directly on the hearth, the latter should have projections on which the material rests, or else flues should be provided through the hearth (see Fig. 2), except in the case of heating thin sections.

In the large furnace in question the hearth makes one revolution in six to ten hours, depending upon the length of the lever arm of the driving ratchet. In consequence, the power which is required to propel the hearth is almost negligible. It is, of course, just as easy to design the hearth for one revolution per hour or for even a shorter time.

Compared to in-and-out furnaces in the same plant, the rotating-hearth furnace showed 100 per cent. increase of production for a given floor space, 45 per cent. saving in labour, 20 per cent. saving in fuel.

What may be stated positively is that they require more care and experience, both in design and in erection, than furnaces with stationary hearths.

The rotating-hearth furnace does not readily lend itself to being used as a muffle furnace, on account of the inaccessibility of the interior of the muffle at the door, unless a disproportionately large part of the circumference is sacrificed for the door. It is very well adapted to being used in conjunction with electric resistors.

The limit of temperature for heating steel on rotating hearths lies at about 1,200 deg. C. At higher temperatures there exists the possibility of forming slag and having it run into the sand seal slot, which fact would introduce complications.

Correspondence.

[*We accept no responsibilities for the statements made, or opinions expressed, by our correspondents.*]

Sir,—Mr. V. Jobson's letter in your issue of March 3 had two statements which should give every foundryman many sleepless nights. They are:—

(*a*) English shops on the average are miles behind in equipment, in spite of the fact that they have the best workmen in the world.

(*b*) How many shops in this country know the cost of each job accurately, or even moderately accurately?

I do not want to appear too critical, pessimistic or add other sleepless nights to these men already overburdened. However, during my investigations into over 300 factories I have been convinced that these English foundries cannot meet the world's trade competition or satisfy the working man until they literally pull down their plants and rebuild on a foundation having an ideal, consistent effort to attain this ideal, or an ideal placed high enough to make effort worth while.—Yours, etc.,

Chas. A. Haynes, A.M.Am.Soc.M.E
Efficiency Engineer.

Newark-on-Trent,
March 8, 1921.

Book Reviews.

Patternmaking, by Ben Shaw and James Edgar. Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price, 2s. 6d. net.

The authors are no strangers to readers of The Foundry Trades Journal, as they are both regular contributors. Their well-known method of getting the best out of ordinary every-day details is followed throughout this useful book. Its price should place it in the hands of every pattern-maker who takes an interest in his work. Though the book is primarily intended for the younger members of the craft, the older craftsmen will undoubtedly derive benefit from its use for revision purposes.

Publications Received.

The Broken Hill Proprietary Company, Limited, 320, Collins Street, Melbourne, Australia. Calendar, illustrated with views of the company's undertakings.

Messrs. August's Muffle Furnaces, Limited, Halifax. Calendar, illustrated with details of the company's manufactures.

Messrs. John MacDonald & Son, Limited, Watt Street, Maryhill, Glasgow. Catalogue of "Ajax" jolt-ram moulding machines.

Cleaning and Dressing Castings.*

By F. W. Wilson.

In dealing with this matter the first thing to be considered is how the work affects the health of the worker.

The fettling shop is by no means an ideal place to work in on account of the large amount of dust and heat usually met with.

The dust comes chiefly from the sand cores, which have to be removed by hand work; these cores having been well baked before putting into the mould, and further heated by the molten metal in casting, powder up in fine dust during removal, often resembling a cloud of smoke when large cores are being removed.

direct from the moulds to the fettling shop, and can be utilised for turning over the heavy work.

Fig. 1 shows a suggested layout for a fettling shop dealing with iron castings up to, say, 20 tons, and could with the usual additional plant be used equally for steel.

The heavy castings are brought into the left-hand bay, and the light ones into the right hand, all castings being sent out at the right hand.

Ample overhead craneage should be provided for the heavy work, and jib cranes on the walls and columns to deal with the lighter work should cover as much of

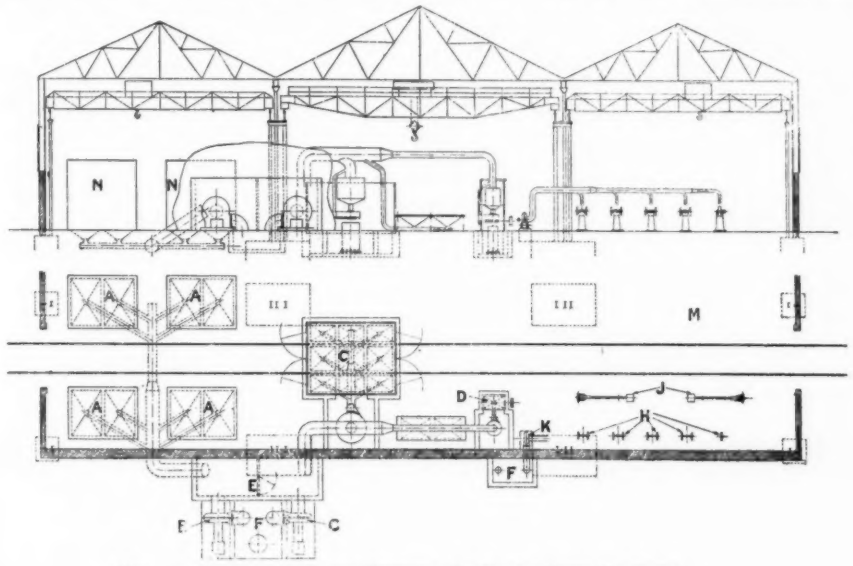


FIG. 1.—ARRANGEMENT OF FETTLING SHOP FOR IRON CASTINGS.

Sometimes the cores have to be removed whilst the casting is still hot, and this adds to the unpleasantness of the work.

Often the shape of the casting demands that the head of the worker must be close to the cores whilst they are being removed, and no escape from the dust is possible. The grinding wheels used for dressing castings give off dust which is regarded as more dangerous than core dust, owing to the sharpness of the particles. The Factory Act (1901) requires mechanical ventilation where dust is generated to an injurious extent. Stringent regulations drawn up by the Home Office are in force to suppress this danger in grinding of cutting implements in iron and steel, and these regulations ought to extend to foundries.

the floor as possible. Runways in the light bay are much favoured, and found extremely useful.

The warming and ventilation of the shop to suit the seasons would pay, but often open fires on the floor in winter and open doors in summer are the only provision made.

The layout of the plant indicated in Fig. 1 shows several pits "A," covered with perforated steel floor plates with hoppers beneath, connected to an exhaust fan "B." This arrangement is suggested as a means of dealing with the dust during the coring of castings.

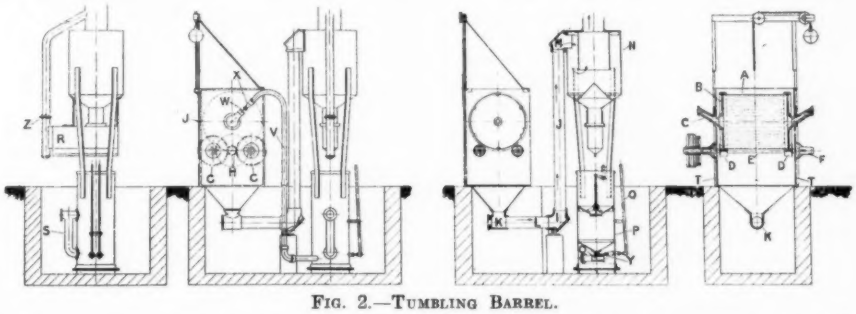


FIG. 2.—TUMBLING BARREL.

Foundry dust does not usually contain any germs injurious to health, but to quote Dr. Oliver, he states regarding dust that: "Its influence in inducing respiratory diseases of a purely mechanical and irritative nature is considerable."

In many iron and steel foundries the most elementary provisions for dealing with the dust are lacking, nothing being done beyond wetting the sand after removal from the casting.

In a foundry handling small, medium and heavy work, the best position for the fettling shop is perhaps at the end of the foundry. The overhead travelling cranes can then be used for bringing the castings

The castings are placed on these perforated floors, and all the sand and dust is drawn downwards away from the worker. Canvas sheets "N" placed round the pits would improve the down draft and make the arrangement more efficient.

The sand would be drawn to a closed chamber "E" (say near the sand shed for convenience in mixing), the light dust being drawn through the exhauster and deposited in a water tank "F."

A perforated floor, say 12 ft. × 9 ft., would require an exhauster capable of dealing with 2,500 cubic feet of air per minute, requiring 5 b.h.p. when maintaining a vacuum of 4 in. on the water gauge, and this would draw the dust down from a height of about 6 ft. and transport about 1 cubic foot of sand per minute.

Incidentally the sand off the castings would be taken away automatically, and against the cost of operating the arrangement must be allowed the hand labour—wheeling the sand away. Similarly, when the work is carried out on benches these might have perforated

* Extract from a Paper read before the Manchester Association of Engineers.

tops with hoppers beneath, connected with the exhauster.

Steel foundry practice varies somewhat from that of iron at this stage, as, with the former, it is sometimes found necessary to put the casting into the annealing furnace practically as it leaves the mould and before it cools, whilst other classes of castings are thoroughly cleaned before and after annealing.

With iron castings, after the risers have been knocked off, the casting passes to the sand blast room where the remaining sand and core are removed.

Where sand blast is not used the casting must be cleaned by tumbling barrel, hand scraping, brushing, grinding, pickling or a combination of these processes.

Pickling is now not used so much as formerly, and few firms carry on the process to any extent, sand blasting having superseded it, as engineers object to the use of acid, claiming that the acid damages the metal. This view appears reasonable, as corrosion may continue unless the washing is very thorough.

Tumbling.—Usually small castings up to 56 lbs. weight are cleaned in bulk in a revolving barrel.

With this method the castings are loosely packed in the barrel together with a proportion of small odd pieces of hard metal having jagged edges, or "stars" as they are termed. When the barrel revolves the castings are thrown against each other, and the tumbling

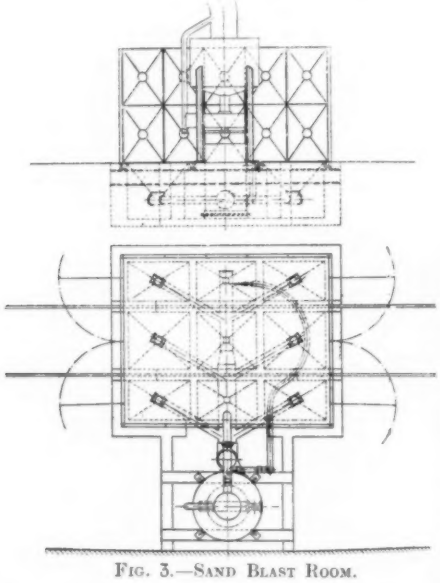


Fig. 3.—Sand Blast Room.

motion, together with a slight abrasive action of the "stars," removes the sand on the outside of the casting, giving a dull, glazed finish. As the barrels revolve at a fair speed, care has to be taken that frail castings are not broken, but usually the work is graded and the light and heavy work are "barrelled" separately.

Tumbling is a slow process, liable to break some of the castings and spoil the sharp edges, but the machine is very simple and is in general use. The barrels are usually 18 in. to 36-in. diameter, 2 ft. 6 in. to 5 ft. 6 in. in length, and of many shapes, from a circle to a regular decagon, the idea being to obtain the best tumbling effect on the castings.

Some types of barrels run partly immersed in water, heated by a steam pipe or jet, and castings are therefore more or less cleaned in a mud bath. The castings dry rapidly owing to the heat absorbed from the water, and this method is in use for certain classes of textile machinery work.

The barrelling of castings is much more expeditiously done in a sand-blast barrel, as shown in Fig. 2. This type of barrel revolves very slowly (about two to four revolutions per minute for most work), and breakages are therefore avoided, even when light and heavy work are dealt with together.

When speaking of "sand blast" "shot blast" is meant unless stated otherwise, as the term "sand blast" is generally used in this sense.

The barrel, which is perforated, revolves in a closed chamber with a hopper beneath, an exhauster being connected to the hopper for drawing away all sand and abrasive.

The barrel is circular, but a segment is made removable to act as a door for charging. Attached to the inside of the barrel are a few bars running longitudinally, which cause the castings to tumble over slowly. No stars are used, but blast jets fixed at one or both ends of the barrel are arranged to guide the abrasive against the castings, which are thus thoroughly and expeditiously rid of sand on the outside, and rid also to a great extent of the cores.

Cleaner castings are obtained by this process in about one-third the time or less taken with an ordinary rumbler.

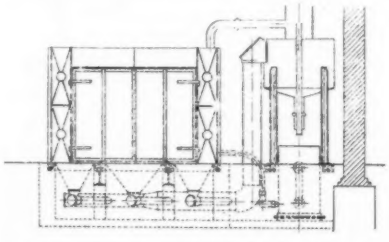
The arrangement shown on Fig. 2 renders possible the re-use of the abrasive as this is drawn up into the settling chamber and automatically graded and separated from sand and dust before re-use.

Small delicate or intricate castings are cleaned in a closed chamber, see Fig. 4. The operator holds the casting in one hand and directs the jet with the other.

Abrasive.

The abrasive used is generally chilled iron shot, the globules being graded in size from 1/20 in. to finest dust. This material can be obtained in almost any degree of fineness, but for cleaning iron, globules measuring 0.035 to 0.040 in. diameter are best, and for steel, 0.045 to 0.050 in. diameter.

Nearly every founder has different ideas on this subject, some using crushed shot of large size, which is certainly very destructive. This crushed shot is becoming popular with steel founders, but is liable to "pit mark" the work, and it causes rapid wear on all pipes conveying it to the jet. It is made by crushing shot which is too large for ordinary work, and so utilises a waste product. The



abrasive must be used absolutely dry. If allowed to get damp or wet it cakes and causes stoppages in the distributing apparatus. Care must therefore be taken to use dry air for the sand-blast process, and this sometimes presents difficulties, as atmospheric air always contains more or less water in suspension. This enters the compressor along with the air and is changed into steam during compression, and unless trapped in the air receiver enters the air main. Cooling the air to condense the steam before it enters the air receiver usually prevents this trouble.

Sharp sand cuts quicker than shot, and is sometimes used for soft metals, such as brass, etc., or when cleaning castings in the open where the abrasive cannot be collected. In the past it has been much used, chiefly on the score of cheapness, but the large amount of dust caused by the particles of sand breaking up on impact with the castings makes it difficult to handle successfully. The sand, being softer than the casting, is quickly pulverised into fine dust, and this dust is useless for sand blasting. To separate the dust from the useful sand is not practicable, without special apparatus.

Crushed or "cornered" shot costs about 10 per cent. more than shot; but as shot lasts twenty times as long as sand there appears little advantage in the use of sand.

Air Pressure.—Usually in England the plant requires comparatively low air pressure, this being the original process, invented by the late Mr. Matthewson, of Tilghman's Patent Sand Blast Company, Limited. In this arrangement the abrasive is fed direct into the air main and so obtains a high velocity with low pressure and low power consumption. For iron castings 15 to 25 lbs. pressure is satisfactory, and for steel 25 to 30 lbs. Beyond these pressures the blast pipe becomes unwieldy, difficult to control, and might be dangerous to the operator if the nozzle became stopped up. It should be pointed out that a separate air compressor suitable for these low pressures is necessary, otherwise if air at higher pressure is used and passed through a reducing valve, considerable loss of power must result.

Sand-Blasting Plant.

The sand-blast room, Fig. 3, should be built preferably of C.I. plates and with a metal roof. Glass roofs are a source of worry through breakage. Electric light from the roof gives good results, but care must be taken to prevent the shot hitting the bulbs. If the pit under the room can be made 6 ft. deep so much the better, as the operator can then comfortably work under the room when cleaning the hoppers. The rooms can be made practically any size, the smallest being 6 ft. square usually, and the largest 30 ft. × 20 ft.

Fig. 2 shows the sand-blast apparatus for collecting, sieving and separating sand and shot, and distributing the shot to the jet.

The apparatus consists of a settling or cyclone chamber connected to the exhauster into which the sand and abrasive is drawn from the hoppers beneath

the room, the very light dust going direct to the exhauster.

The heavier material collects in the conical hopper at the bottom of the cyclone chamber and falls through a grading tunnel, where the remaining sand is separated from the shot. The shot then falls into the sand-distributing chamber placed vertically beneath the cyclone separator. This distributing apparatus is divided into three compartments. The top one collects the shot after it has been separated from the sand and passes it by means of a hand-operated valve into the centre compartment. A valve arranged in the bottom of the centre compartment regulates the flow of shot to the mixing tube, where it falls into the stream of compressed air and is driven to the blast jet.

A vacuum of 4 in. water is quite enough to ventilate the room and to elevate the shot as it returns to the collecting apparatus, but the exhauster must be capable of removing the air in the room three or four times per minute. Under these conditions the operator's view is not obscured by the sand and dust removed by the blast.

BLAST PIPE.

The shot is conveyed from the apparatus to the blast nozzle inside the sand-blast room by a rubber tube about ten times the area of the nozzle, and this tube

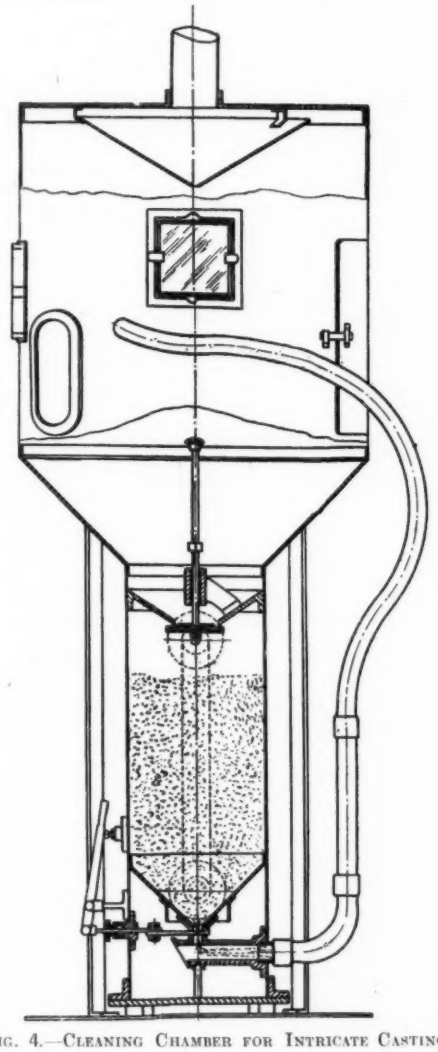


FIG. 4.—CLEANING CHAMBER FOR INTRICATE CASTINGS

being flexible the operator is able to direct the blast on any part of a casting within his view. A point not to be overlooked is that the blast can be concentrated on any portion of the work, and hard patches of sand thus cut away in a thoroughly satisfactory manner.

The levers for controlling the air and shot are located at the side of the room, and two operators are frequently accommodated in rooms of large size.

The operator is provided with a leather helmet, to the bottom of which is attached an ample skirt, the skirt being loosely drawn around his neck by a band to prevent ingress of dust. A renewable celluloid window is attached to the front of the helmet. Into the top of same a compressed-air supply from the air main is conveyed by means of a small rubber pipe. This compressed-air supply maintains the air inside the helmet at a slightly higher pressure than that outside, consequently the operator cannot breathe the dust. In fact, the sand-blast operator has by far the healthiest job in the fettling shop, and this view is borne out by the small amount of sickness observed amongst men working in sand-blast rooms.

The air supply to the helmet passes through a valve adjusted by the operator, is kept free from germs by the heat of compression, and is passed through a water filter to trap any oil.

As the sand-blast process quickly destroys everything it touches, except perhaps rubber, the operator should be provided with long canvas coat, kept clean and free from dust, and, in addition, protective spats for his boots, also rubber gloves to protect the hands. Stress should be laid on keeping the helmet and coat clean, in the interest of health and comfort.

Nozzles.—These are made from the hardest cast iron (preferably chilled), and vary in bore from about $\frac{1}{4}$ in. to $\frac{7}{8}$ in. For the general run of iron and steel foundry work $\frac{5}{8}$-in. bore nozzles are generally used. On work having narrow surfaces, it is more economical to use a smaller jet, as the shot spreads and covers the surface equal to 30 times area of the nozzle, and considerable waste must take place on very narrow surfaces.

Surface Cleaned.—A $\frac{5}{8}$-in. bore nozzle will clean 12 sq. ft. of iron, or 3 sq. ft. of surface on steel castings, per minute, where the scale is of an average character, using in the former case 200 cub. ft. free air per minute at 15 to 25 lbs., and in the latter case 250 cub. ft. of free air per minute at 25 to 30 lbs.

Many designs of sand-blast plants are in use here, on the Continent and in America, which permit the operator to stand outside the sand-blast room and direct operations. Flat revolving tables, sometimes half inside and half outside the sand-blast room are used for flat work, the jet or nozzles being either fixed or moved mechanically to approximately cover the surface of the castings as they are carried round on the table, but considerable handling is necessary for examining and turning the castings over. Moving parts should be avoided in sand-blast plants as far as possible, owing to the destruction caused by the shot.

Rotary tables wholly inside the room are in use for miscellaneous work, and many other combinations are seen, but few are dustless or protect the operator thoroughly. None of these (in the author's opinion) give such expeditious and satisfactory work as is obtained by the operator inside the room, where he directs the jet on the work as required by the varying nature of the scale. In passing, it should be noted that the operator wearing a helmet as described can work hours without coming out of the room and without inconvenience or injury to health.

After sand blasting it is of the utmost importance that all the shot be blown out of any pockets in the castings if these are to be machined, as shot is not good for machine tools.

Grinding.—With the improved abrasives now used for wheels, grinding is economical, and the grinding away of the fins and gates on castings up to 56 lbs. can be handled expeditiously on bench or floor grinders. The machines must be of heavy design to absorb vibration due to any unbalanced revolving parts, and the machines should be securely bolted down for the same reason. The wheel soon becomes more or less out of round in working, and should be trued-up frequently. If vibration occurs it causes hammering, and as the operator cannot hold the work securely against the wheel, the wheel wears very rapidly out of truth.

The rim speed of the wheels should be kept constant between 4,500 and 5,000 ft. per minute, and arrangements provided for speeding up as the wheels wear, or alternatively for running machines at different speeds and changing the worn wheels on to faster-running spindles.

If the wheels run below speed, excessive wheel wear takes place and less metal is removed per unit of time and per cubic inch of wheel. With a suitable wheel 1 cub. in. of cast iron is reported to have been removed in half a minute, but this result seems much better than can be normally obtained.

For heavy work which cannot be handled at the floor or bench stands, the swinging grinder is much used. In this case the work lies on the floor and the wheel, carried in a swinging frame, is brought over it. The wheel is arranged to work at any angle, from vertical to horizontal, and all the movements are by hand. Some very handy electrically-driven sets are seen in the steel foundries where this type of grinder is popular. Exhaust ventilation is not used.

With wheels running at the high speeds necessary for economical work, substantial wheel guards must be provided, strong enough to prevent serious accident should a wheel burst, and should preferably be of steel strongly secured to framework. If wheels are carefully mounted the danger can be avoided, as defective wheels are usually found in tests made by the makers, but with cramping discs of unsuitable design a wheel can easily be made unsafe. Careful mounting does not obviate the constant danger of breakage caused by castings becoming jammed between the rest and the face or side of the wheel.

The dust from grinding wheels is very injurious, and the special regulations issued by the Home Office deal

with the precautions necessary. These regulations do not cover foundry work, but they should be applied to this department. It is stated in Dr. Elliott's book that the average age of men engaged on dry grinding in one locality is 39.4 years, ironworkers 48.3 years, and the rest of population 54.4 years. These figures if only approximately correct as regards fettling shops, emphasise the need of special precautions. As much of the wheel as possible should be enclosed in a metal guard and connected to an exhauster. This should be given sufficient vacuum to draw away from the worker all worn abrasive sand and dust. The exhaust arrangements provided are often hopelessly inadequate, and the question arises, why dry-grinding machines are sold without having embodied in the design a complete exhaust equipment, including water tank for settling the dust.

Dressing. — Pneumatic hammers are not generally favoured by iron dressers, probably on account of the jar on the arm caused by hammer when the brittle chips break away; but they are used in some iron foundries for chipping and clearing cores.

When steel castings are dressed with pneumatic chipping hammers much laborious hard chipping is avoided, and a man using a pneumatic hammer absorbing about four b.h.p. in compressed air will get through a great deal more work than is possible with hand hammer.

The risers and gits on steel castings are usually very large, and take much time and power to cut off. Circular saws of all sizes up to 5 ft. diameter are used for this work, and many fine tools of this kind are seen in the steel foundries. In most machines the saws are vertical, but in others the saws lie horizontally. The upkeep of saws must be a serious item, as apart from sharpening they are easily broken if a casting moves under the cut. Often the shape of the casting and position of the riser necessitate using other types of machine tools for this work.

By using the sand-blast process 25 per cent. and upwards of the fettlers' wage bill can be saved, the saving being greatest on intricate work.

Properties of Furnace Materials.*

By W. NEWTON BOOTH, ASSOC.M.INST.C.E.

The furnace designer has to select his materials to meet a number of mutually contradictory requirements; and it is therefore necessary to study the physical properties of the materials available. The points to be watched are, of course—first refractoriness or ability to work at high temperatures; mechanical strength to withstand at the temperature attained the stresses imposed by the design; thermal conductivity, which for some purposes should be as low and for others as high as possible; and last, but not least, cost.

Table I. gives the principal properties of the furnace

TABLE I.—*Properties of Refractory Materials.*

Substance.	Refractory test.	Working temperature.	Mechanical Strength tons per sq. in.	Thermal Conductivity. C.G.S.	Approximate cost. Per lb.
	Deg. C.	Deg. C.			d.
Firebrick	1630	1300	0.5	0.002	0.175
Porous brick ..	1500	1000	0.04	0.0004	1.91
Silica brick ..	1710	1400	0.35	0.003	0.275
Magnesia brick ..	1800	1600	2	0.017	1.12
Chromite brick ..	1800	1600	1.75	0.006	—
Bauxite brick ..	1900	1700	—	—	—
Carborundum ..	2200	2000	6.5	0.0243	18
Carborundum bonded ..	2000	1800	5.6	0.0275	12
Alundum	2000	1800	—	0.004	—
Zirconia	2600	2300	—	—	48
Ni.Cr. alloy ..	1400	1000	12	0.10	66
Stainless steel ..	—	830	40	0.10	33

materials now in use. It will be seen that, as the refractory test required goes up, the price increases very rapidly; and it is only for purposes where the ordinary silica or fireclay bricks are unsuitable that the use of the more expensive materials can be justified. A short description of these refractories is given.

Fireclay and Silica.—This material is much the cheapest refractory, and consists of aluminium silicates in various proportions, from a pure clay containing about 40 per cent. of alumina, through the ordinary fireclays containing about 30 per cent. of alumina to silica brick containing 96 per cent. of silica. Its refractory properties are much affected by impurities; and a good brick should not contain more than about 2 per cent. of iron oxide and 1 per cent. of alkali salts. The bricks are acid in character, and are therefore rapidly attacked by basic slags; and this point should be watched in designing furnaces, where they are formed. In favourable circumstances these bricks will give satisfactory service if the working temperature does not exceed about 1,400 deg. C.; but the life is rapidly reduced at higher temperatures.

Porous Brick.—This is a comparatively new addition to the commercial furnace materials. It is made of various materials; one form being chiefly fireclay to which sawdust has been added. On burning, this is consumed, and a porous brick is left which owes its low thermal conductivity to the air contained in the pores. The material will probably prove very useful for heat insulation in furnace outer walls.

Magnesia.—This material is very highly refractory. On being subjected to rapidly altering temperatures it spalls badly, and is consequently not suitable for such conditions.

Chromites.—These consist chiefly of an oxide of chromium. They are fairly highly refractory.

Carborundum.—This is a silicon carbide made in the electric furnace. It is very strong, has a relatively high conductivity, and a very high refractoriness. The price is rather high. A cheaper quality is made by bonding carborundum with a small proportion of china clay. The result is inferior in practically all its properties, but is still highly refractory.

Zirconia.—This is a new very high quality refractory, at a correspondingly high price. Its use is limited on this account.

Nickel Chrome.—The demand for high conductivity refractory material has been met by the introduction of alloys consisting chiefly of nickel and chromium, which possess all the good mechanical properties of a metal, and yet will stand heating to high temperatures without sensible oxidation. The price is high; but as the metal can be cast in thin tubes, its weight can be made relatively small.

Stainless Steel.—So-called stainless steel will withstand a temperature of over 800 deg. C. without scaling: and this material will probably be much used in future for small furnace parts.

A method of treating iron tubes with powdered aluminium, so as to render them resistant to heat, is also promised; but very little information is yet available as to this process.

Thermal Efficiencies. — Regarding the thermal efficiencies shown in Table I., it will be seen that considerable progress has been made; and it is safe to predict that before long it will be possible to attain efficiencies of 50 per cent. at the temperatures commonly required, viz., under 1,400 deg. C.

TABLE II —*Relative Costs of Fuels.*

Fuel. Kind.	Price.	Capacity of Installation. Therms per hour.	Cost per therm supplied.	Assumed efficiency at 1000°.	Cost per therm usefully employed.
	Per therm.		d.	Per cent	d.
Coal gas ..	10.75d.	—	10.75	25	43
.. ..	8d.	—	8	25	32
Blue water gas ..	6d.	60	6	25	24
	Coal per ton.				
Producer gas	50s.	50	6.6	20	33
Self-contained producer ..	,,	300	5.6	25	22.4
.. .. ..	,,	5	6.5	25	26
Direct fire ..	,,	5	4.33	8	54.1
	Per gallon.				
Crude oil ..	1s.	—	6.85	25	27.4
Coal-tar oil ..	1s. 2d.	—	8.9	25	35.6
Refined oil ..	2s.	—	15	25	60
	Per unit.				
Electricity ..	1d.	—	20.2	60	48.6

In calculating the figures in Table II., an efficiency of only 25 per cent. has been allowed for in endeavouring to show the position of coal gas as an industrial fuel. The question of the figure to be ultimately attained will not affect the relative position much, except possibly to accentuate the inferiority of solid fuel used in direct fires, as increases in the duty obtained from one type of furnace will be followed by corresponding increases in the others. In the costs given no allowance is made for the advantages of coal gas, as their monetary value must be assessed for each particular case.

The table appears to show that town gas will have a future before it for all operations on a scale below that which will allow of the economical use of producer gas; and that in many cases where the cleanliness, regularity, small space occupied, and high efficiency of coal-gas apparatus is important, this will turn the scale even in large installations.

* Extract from a Paper recently read before the London and Southern Junior Gas Association.

ITALIAN MINERS FOR FRANCE.—The French Government has offered Italy six tons of coal per month for each Italian miner induced to go to France, and the Commissioner of Emigration of Italy is advising his people to emigrate to France. It is asserted that opportunities are better there than in America, both for steady work and high wages.

Wellman Mechanical Gas Producer.

With the increasing necessity for fuel economy due to the difficulty of obtaining good coal at a reasonable price, and the absolute necessity of reducing working costs, the subject of gas and its production is of great interest to the manufacturers of this country.

There are many types of gas producers each with different methods of operation, but when considering these it should be constantly borne in mind that successful and efficient gasification of solid fuel entirely depends upon the following factors:—

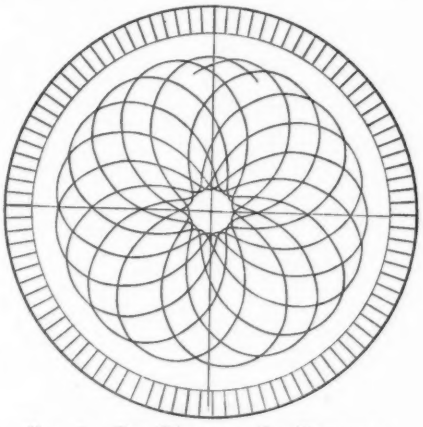


FIG. 1.—THE WELLMAN GAS-PRODUCER.

(1) Regular feeding of the fuel.
(2) Maintaining a compact fuel bed.
(3) An even distribution of blast over the whole area of the fire bed.

Regular Feeding.—The Wellman gas producer, shown in Fig. 1, is fitted with a set of two mechanical coal feeds, which are placed on the top plate at different distances from the centre. Each feed consists of two elements; the first is a variable speed four-arm vane regulating the amount of coal discharge; the other element is a five pocket feed valve revolving at a constant speed in a machined seat. This device feeds the coal at a

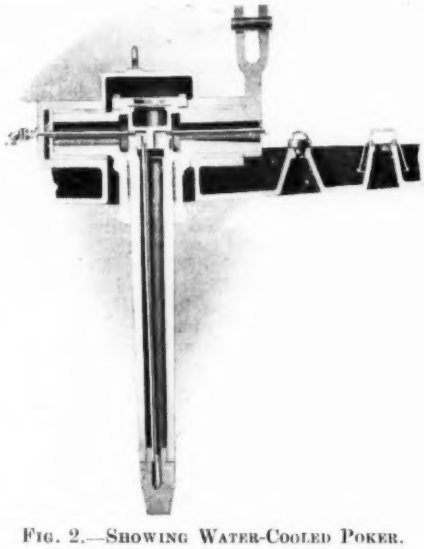


FIG. 2.—SHOWING WATER-COOLED POKER.

speed proportioned to the rate of gasification, at the same time it prevents gas leakage. For every 9½ deg. of rotation of the producer, coal is discharged from each feed. As the feeds discharge alternately, there will be a discharge of coal every 4¾ deg. of revolution. This ensures a practically continuous flow of coal into the producer.

The upper measuring wheel revolves in an upward direction with reference to the main body of the fuel. This lifting or shovelling effect keeps the down-coming coal loose and free from packing tight in the downtake.

Grinding or crushing of the coal is avoided and a positive feed regulation is obtained dependent upon the speed of the measuring wheel. Nor does grinding or crushing occur on the upper half of the measuring wheel, as clearance is provided between the wheel and the case.

A water drip lubricator moistens the valve seat and keeps the tar plastic and the valve seat lubricated.

Compact Fuel Bed.—The most characteristic feature of the Wellman producer is the mechanically operated poker, which is suspended from trunnions. The poker shown in Fig. 2 is operated by ratchet gearing, actuated by a crank and crankshaft which is driven by a reduction gearing connected to the main shaft.

The arrangements of the rotating and poker mechanisms on the machinery column make the bearings easily accessible and give a rigidity which tends to keep the bearings in perfect alignment. All gearing is protected by sheet steel guards.

The poker is water-cooled, and it is suspended from the cover and extends into the fuel mass, penetrating through the green fuel zone into the zone of incandescent fuel. It is actuated by the driving mechanism and swings back and forth in a vertical plane as the mass of fuel revolves. The path of the poker, from the centre to a point a

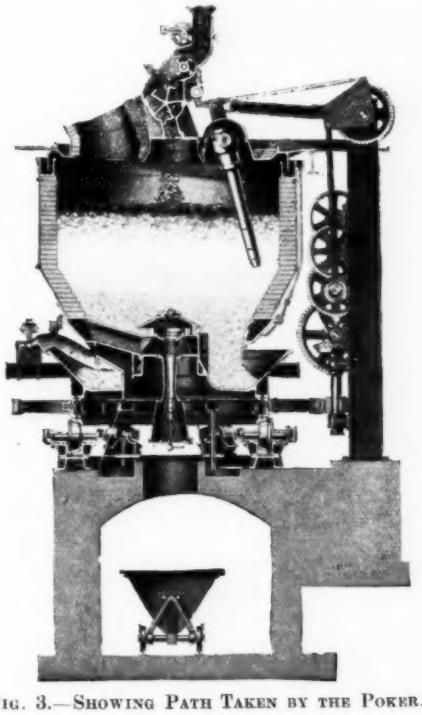


FIG. 3.—SHOWING PATH TAKEN BY THE POKER.

few inches from the brick lining of the shell, describes a series of loops as shown in Fig. 3.

By this combined action, the soft, partly decomposed fuel above the incandescent zone is prevented from caking. The gas is liberated and the incandescent zone itself is kept free from clinkers so that the fuel descends positively toward the ash-pan.

Gas fuels in the process of gasifying tend to form a pasty mass, which, if not broken up, makes a seal through which the gas cannot escape freely. Clinkers, if they are allowed to form, also interfere seriously with combustion and prevent the proper progress of the fuel downward from the top toward the ash-pan.

The mechanically-operated poker stirs the fuel mass constantly and prevents either of these difficulties from interrupting the steady production of a rich gas.

Distribution of Blast.—In the Wellman producer the proper amounts of air and steam are introduced by a special blower. The blower, with blast inlet pipe and cast-iron deflecting plate, is at the

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base of the producer. The amount of steam used controls the amount of air admitted, and hence controls the quality and quantity of the gas.

The steam entering at the base of the blower passes up through three conical shaped ports, each a little larger than the preceding one. At each port air is drawn in, which mixes with the steam. This blower distributes the blast to the sides of the fuel mass as well as to the middle, thus adding materially in the regulation of combustion and the gas making process.

Capacity. — The Wellman producer using mechanical feeders will gasify 3,000 lbs. of ordinary bituminous coal per hour under normal working conditions, forming a gas containing an average of 148 b.t. units per cubic foot, and with a loss in the ash of less than 1 per cent. of the combustible charged.

The Wellman producer is manufactured by Messrs. The Wellman Smith Owen Engineering Corporation, Limited, of King's House, Kingsway, London, W.C.2.

Slag Pots.

The "Scandinavian Foundry Journal" gives the description of preparing the moulds for heavy slag pots in loam. The firm took an order for eight of these pots, which were all to be delivered within eight weeks. Consequently there was no time for preparing special patterns, and the pots had to be cast without any. The following was the *modus procedendi*:—

Each pot weighed 9 tons. The diameter at the top was 2,740 mm. (9 ft. 4 in.) and the height of the pot was 2,890 mm. (9 ft. 10 in.). The width of the flange on top was 125 mm. (5 in.) and there were four brackets (G) for suspending the pot in its truck.

A pit was dug in the ground, on the bottom of which a layer of coke breeze was spread 60 mm. (2½ in.) deep, on which was bedded the foundation

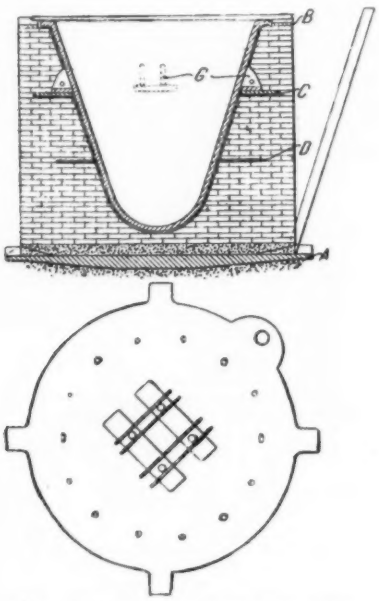

Fig. 1.—Slag Pot Mould in Loam.

plate for the vertical spindle of a revolving strickle board. As shown in Fig. 1, the mould was built up in brickwork with common bricks outside and refractory bricks inside. At B, C, and D three iron rings, 30 mm. (1¼ in.) thick and 250 mm. (10 in.) wide were built in, the purpose of which was to relieve and distribute the weight. Ring C was covered with a thin layer of loam, which was levelled true with a revolving strickle board, and was allowed to dry overnight. The next morning the patterns for the four brackets (G) were placed in position, the brickwork was completed and allowed to dry overnight. The inside of the mould was then plastered over with loam, which was made smooth and true with a revolving strickle board, and after being dried received two coats of graphite.

In the meantime the core was prepared in another portion of the works. Its construction is clearly shown in Fig. 2, to consist of a cast-iron

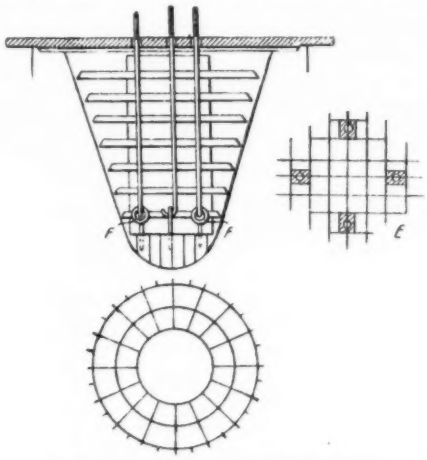

Fig. 2.—Core and Grid for Moulding Slag Pots.

grid E, provided with suitable eyelets (F), by means of which the core is attached to a top-plate. This top-plate is surmounted by a loam-cake of 3,660 mm. (12 ft.) in diameter.

Provision is made for runners and users, and the mould is finished off in the usual way.

Rustless Iron.

Whenever iron and steel articles are exposed to the atmosphere there is a liability to oxidation or corrosion, and it is often essential to protect against this in some way. Galvanising, Bower-Barffing, Tinning, "Sherardising," "Calorising," "Coslettising," enamelling and electro-plating, are but a few of the better known methods of rust prevention which are being adopted at the present day, and hundreds of other processes have been proposed and patented, the majority of which might be more truthfully described as "finishes" rather than reliable methods of preventing corrosion.

An ironfounder or manufacturer who is desirous of having certain castings or articles of iron and steel made rustless may naturally be a little puzzled as to which process to adopt for his particular class of work, and a brief description of one of them may be of value.

The Bower-Barff process is a combination of the processes of Mr. A. S. Bower, engineer, of St. Neots, and Professor Barff, of Kilburn. It has been worked for over 30 years by the Rustless Iron Company, Limited, Trico Works, Keighley, who have during this period introduced such improvements and alterations as to justify them in renaming it the "Trico" process.

It differs from most other methods, such as galvanising, tinning, painting, etc., in that there is no added layer of a foreign metal or substance, but the surface of the iron itself is converted into a rustless condition, namely, into magnetic oxide of iron or Fe_3O_4.

A great advantage of this is that there is a closer "union" between the rustless surface and the rest of the article than in the other processes; moreover, there is no necessity to resort to pickling with acid prior to treating, this being a common source of corrosion in electro-plating processes.

The non-corrosive qualities of magnetic oxide of iron are well known. Anyone who has handled a lump of it in the form of "Lodestone," or the famous ore from the Dannemora mines in Sweden, will recollect its hard, black and slightly lustrous character, although it may have been exposed to atmospheric influences for centuries. It is indeed a most striking fact that magnetic oxide, Fe_3O_4, which stands between the unstable ferrous oxide, FeO, and ferric oxide, Fe_2O_3, as regards degree of oxidation, should be so permanent and stable when exposed to corrosive agencies, and harder

than iron itself. Its stability is largely due to the fact that magnetic oxide is not subject to disintegration by hydration.

Knowing this fact, however, the next step is how best to apply it in practice. It is quite an easy matter to produce a coating of Fe_3O_4 *of a kind;* indeed, it is done whenever bar or sheet iron is rolled, as is seen by the blue appearance. Every student of chemistry recollects that in decomposing steam by passing it over red-hot nails the latter are covered with Fe_3O_4.

Hundreds of years ago the Highlanders of Scotland used to fill their three-legged "kail pots" with wet moss and surround them by fire, when the steam thus generated would "rustproof" the interior of the pot to a slight extent.

But to apply the process on a manufacturing scale; to consistently produce a regular coating of adequate thickness without blistering or scaling; to vary this thickness, if need be, for special requirements; to treat articles of all shapes and sizes and of every variety of iron and steel; these are problems which can only be solved by years of experience and by employing all the "control-apparatus" of modern science.

It must not be supposed that the "Trico" process will withstand acids or violent chemical reagents, but for ordinary oxidising conditions, produced by the atmosphere and hot or cold water, it is a really reliable method of rust prevention, and should still find many useful applications.

When the Bower-Barff process was first introduced it was applied to all manner of articles, for many of which it was quite unsuitable, and a good deal of money was lost in this way. It is to the credit of the Rustless Iron Company that they were the first to apply it to cast-iron furnace pans or coppers, for which it is peculiarly suited.

The next most important application of the process was to cast and wrought iron boilers for hot-water installations. The conditions prevailing in a small cast fire-back boiler are much more severe as regards corrosion than in a furnace pan, but here, again, practical experience (which is the best guide in methods of rust prevention) has proved the efficacy of the process.

It has also been successfully applied to kitchen hollow ware, rain-water goods, baths, water meters, tanks, dyeing machinery, and a host of other articles.

It has received official Government recognition by being specified for a number of articles required for housing schemes appearing in the list of light castings issued by the Department of Building Materials Supply.

Drawing Patterns.

BY JAMES EDGAR.

Passing through a large patternshop recently, the writer observed that on a large square pattern, which was painted and waiting for the foundry lorry, no provision had been made for its delivery from the sand. The pattern was made in a work-

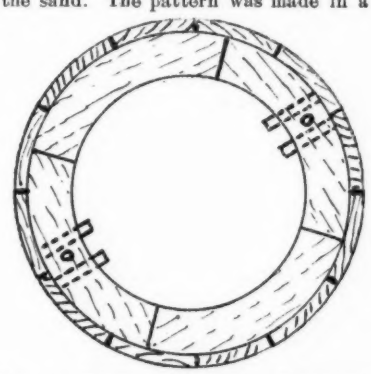

FIG. 1.—SHOWING METHOD OF STRENGTHENING WHEN TWO RODS ARE USED.

manlike manner, the grain of timber running so that there would be no locking in the mould, all loose pieces were either dowelled or dovetailed—but no provision had been made for getting the pattern out of the mould. The work was obviously made by an expert craftsman, so the provision of some drawing arrangement could not have been overlooked. Presumably there were no plates about, so it was decided to leave the matter to the foundry to make its own arrangements. It is a fact that many young patternmakers become journeymen without ever having seen drawing and rapping plates, straps or drawing rods, and they look rather foolish when they go into a shop where it is customary not to leave it to the foundry. It is rather significant, also, that it is not always the first-class shops that look best after the delivery of the patterns from the sand. It may be going too far to say that nothing should be left to the moulder, because frequently a good deal must be left to him, but certainly all that is practically possible should be done before the job leaves the patternshop.

It is sheer folly to make a first-class pattern and not endeavour to minimise foundry wear and tear. Nothing is more destructive than spiking a small pattern or hammering in a screw; and it is such a simple matter to set in a small plate. One excuse

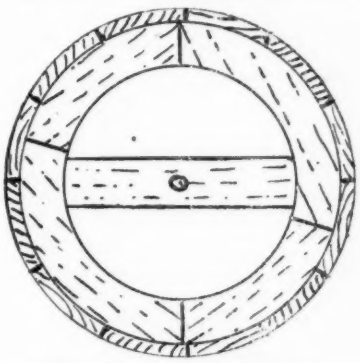

FIG. 2.—SHOWING METHOD OF STRENGTHENING WHEN A CENTRE ROD IS USED.

sometimes made for not screwing straps or fitting a rod to a pattern is that, being a framed-up job, the moulder can get a sling round the frames inside and haul away. What is forgotten is that the moulder, not being a patternmaker, does not know which part it is safe to put his sling round. Furthermore, it is very bad practice to put such an unnecessary strain on a pattern. The writer has on more than one occasion seen a pattern badly damaged by being drawn from the mould in this way. It is very difficult also to equalise the strain and get a steady pull in this way.

In every case delivery from the mould should be considered before the pattern goes to the foundry. Sometimes the matter may be left to the patternmaker in attendance at the foundry, if there is one, but, on the other hand, it is wiser to give the matter attention when building the pattern. For instance, take the case of a large cylindrical pattern which will be moulded on end. If it is of huge proportions two rods are necessary, placed at equal distances at either side of the centre line, but if small a centre rod is sufficient. If it is comparatively small, and the barrel is constructed of grounds kept the correct distance apart by means of checked stays, it is fairly safe to set a plate on the bottom side of the bottom bridge if this ground is fairly thick, without any special local strengthening, but with a larger barrel precaution must be taken or the grounds will be drawn out of the staves. Fig. 1 shows how the pattern may be strengthened when two rods are used and Fig. 2 when a centre rod is used.

The ordinary form of draw straps is quite good for big square or rectangular work, but it is wise, if the pattern is at all fragile, to stiffen it up locally.

A HISTORICAL NOTE.—According to Mr. Alfred G. King, in a lecture before the American Society of Heating and Ventilating Engineers, the first cast-iron boiler was made by Mr. George B. Brayton, at Westerley, R.I., in the year 1849, and was used on a small locomotive. The first firm to manufacture the present type of cast-iron column radiator with sections nippled together, was Messrs. Bundy and Healy, New York, during the period 1880 to 1890.

The Making of Iron and Steel.*

By D. Sillars.

The class of substances known generally as the iron-carbon alloys consist of compounds of iron and carbon in proportions up to 4.3 per cent. carbon. Pure iron melts at a temperature of 1,530 deg. C., but if the pure metal is melted in the presence of carbon it dissolves the carbon and forms a series of alloys having successively lower melting points with each increase in carbon present up to 4.3 per cent. Any increase in temperature over the melting point of pure iron (1,530 deg. C.) will cause more carbon to be dissolved, but on cooling the metal down to the melting point the additional carbon so dissolved falls out of solution and an alloy containing 4.3 per cent. of carbon is left. Engineers may require to use any one of these alloys or their commercial equivalents; cast-iron being at the upper end of the scale of carbon values and wrought iron at the lower extreme.

The Blast Furnace.—Iron is the cheapest, and, next to aluminium, the most abundant metal in the earth's crust, forming 5.5 per cent. of the total weight of the latter. Both iron and aluminium are found naturally combined with oxygen, but iron possesses the great advantage of being easily removed from its associated oxygen and reduced to the metallic state. The operation of recovering iron from the ore is of the simplest character, and may be accomplished by heating the ore in contact with a piece of carbon or any combustible body containing carbon, such as wood, coal, etc. In modern practice the operation is conducted in a shaft furnace which consists of two firebrick cones disposed one over the other with their bases together, the truncated lower cone is extended downwards into a cylinder, also lined with firebrick to a thickness of about 3 ft. on the sides and 6 ft. on the bottom, forming the hearth in which the molten metal and slag collect and from which they are tapped by two orifices disposed one above the other, but about 12 ft. apart around the circumference. The lower cone is the "bosh" and the upper cone the "shaft."

The mixture of ore fuel and flux are charged into the furnace at the top in a uniform manner and in predetermined proportions. Air at a pressure of about 7 lbs. is blown into the furnace through a number of orifices called tuyeres situated at the top of the hearth.

Upon entering the furnace the oxygen of the air combines with the carbon of the fuel, and forms the highly reducing gas, carbon monoxide, which, having a great affinity for oxygen, abstracts that element from the ore in the upper part of the furnace according to the types of chemical reaction represented by the equation $Fe_2O_3+3CO = Fe_2 + 3CO_2$.

The iron so liberated from its associated oxygen descends the furnace in contact with the carbon, and, on reaching the foot of the bosh, melts and flows to the bottom of the hearth while the impurities in the ore, sand, clay, etc., combine with the lime flux and form the slag. Such is a very brief account of the manner and recovery of iron from its ores, but it is sufficient to show that here we have the condition referred to earlier, in which iron is melted in contact with excess of carbon, and it therefore may be expected to contain about 4 per cent. of carbon. A certain proportion of the impurities contained in the ores also undergo reduction by the carbon and enter the iron. Especially is the oxide of silicon always contained in ores as sand reduced to silicon, and dissolved in the iron profoundly modifies the characteristic properties of the metal. Sulphur in small but variable amounts also enters the iron from the ore and coke, and all the phosphorus is to be found in the metal, and indeed it is the presence of this latter element that enables many of the intricate castings required in trade to be fashioned. Phosphorus confers fluidity on the molten iron whereby it is able to flow into and fill up the mould.

Hematite pig-iron is made from ores relatively free from phosphorus, and although this metal is tougher and withstands rapid changes of temperature to a much greater extent than phosphoric iron its great viscosity makes it unsuitable for any but heavy-section castings of plain design.

Pig-Iron.—The most essential difference in the composition of pig-irons is the distribution of the total carbon between free carbon or graphite and combined carbon. The grey-iron owes its colour to the graphite contained in it and as the proportion of this constituent lessens, we approach a white-iron in which all the carbon is in the combined state, a condition which renders the iron very brittle and unfit for any purpose where strength is required.

Malleable Iron.—If, however, hematite-iron containing not more than 1 per cent. silicon be cast from a very hot furnace the high temperature enables it to be run into very small and intricate castings which on cooling show a white fracture and a glass-like brittleness. This brittleness is due to carbide of iron, a compound of intense hardness which forms a characteristic feature of white-iron. If these brittle castings are packed in iron-ore in an air-tight box and heated for some hours to a temperature of 1,000 deg. C., or thereabouts, on cooling, the castings are found to have a dark-grey fracture surrounded by a thin skin of metal containing very little carbon. The oxygen of the ore in which the castings were packed has removed the carbon from the surface, but the principal change which has taken place is the decomposition of the hard carbide of iron with the deposition of the carbon as a finely-divided graphite, known as temper carbon. The castings which previously were glass-hard are now capable of giving a good bend, hence their name of malleable cast-iron. This material may therefore be looked upon as a variety of more or less pure iron in which very fine particles of carbon are suspended and the ductile property now possessed is due to the change in constitution brought about by the hard carbide of iron becoming decomposed and depositing free-carbon, which is soft and not coherent with the iron.

Puddling Furnace.—If pig-iron be heated in a reverberatory furnace to its melting point, as in the manufacture of wrought-iron, the excess of oxygen always present in coal-fired furnaces combines with the carbon, silicon, phosphorus and manganese forming the oxides of these bodies. It also combines with a portion of the iron to form oxides of iron, the oxide of iron and silica then in turn combine with one another to form a slag of silicate of iron, in which slag the other impurities dissolve. As a consequence of the removal of the impurities in the iron by this process of oxidation, the remaining iron becomes purer, and therefore more difficult to melt at the temperature of a reverberatory furnace. With each degree of purification the originally fluid metal thickens until it becomes so plastic that it can be worked into a ball by the puddler's rabble, and is finally removed in this condition of incipient fusion and hammered out at the forge to a bloom, a large portion of the slag enclosed in the ball of puddled iron by the working of the semi-molten metal in contact with the molten slag is squeezed out during hammering, but a sufficient amount is left behind in the metal to give the slaggy fracture characteristic of all wrought irons, a particular in which pig-iron purified by a plastic working process differs from that purified by a process in which the final bath of metal is in a completely molten state.

Some bodies possess the property of diffusing into one another when held in close contact, and this action is accelerated by an increase of temperature. In the course of a few years, at ordinary temperatures, gold has been found to diffuse several inches into a mass of lead upon which it had been hammered.

The Cementation Process. — Wrought-iron embedded in charcoal and heated to 900 to 1,000

* Paper read before the Middlesbrough High School Engineering Society.

deg. C. rapidly becomes penetrated by carbon, the depth and concentration to which it proceeds varying directly as the temperature and time of contact. Apart from certain primitive processes this was the original method of making steel, but, as might be expected, the product is very heterogenous, both on account of the slag contained in the original wrought-iron and also, due to the inequality of penetration by the carbon, articles made from cemented bar were unreliable.

The Crucible Process.—In 1790 Benjamin Huntsman, a watchmaker, who had been greatly hampered in his craft by this want of uniformity in the steel he used for his watch springs, conceived the idea of melting the cemented bar completely in a clay crucible and casting it into ingots which he worked under the hammer. This was the first steel made by the melting process, and rapidly it displaced the cementing process for such small articles as could be made in crucibles, especially as it was found that the hardness could be varied at will by melting mixtures of cemented bar and wrought-iron together. Huntsman's process is still used to a large extent to-day, but the cementing process has been superseded by the modern Bessemer and Siemens processes, although cementing of iron is still carried on for the purpose of imparting to soft and tough iron or steel a very hard wearing surface or case.

The operation of removing impurities from pig-iron is dependent upon the activity with which oxygen combines with these impurities and with iron itself at high temperatures. This activity, however, is limited in its speed of operation by the concentration of the re-acting bodies, and by the intimacy of contact existing between them.

When a coal-fire burns there is a high concentration of carbon present in the grate, but the other re-acting body, oxygen contained in the air, is limited to that amount which the draft of the chimney can carry over the heated fuel. If the amount of oxygen is increased by means of bellows the fire burns more rapidly. Only the carbon at the surface of the lumps of coal, however, is active, since the air can only come in contact with the fuel at the surface, and consequently the speed of reaction between carbon and oxygen is limited by the amount of surface exposed. Air being a gas its surface of contact is relatively unlimited.

An enormously increased contact surface can be obtained by igniting a stream of finely-powdered coal in a current of air, whereupon the speed of reaction is so greatly increased that the temperatures attained are much higher than is possible by burning coal in any other way.

The Bessemer Process.—A gaseous body, such as air forced at higher pressure into a liquid like molten pig-iron presents opportunity for a very intimate admixture of the two bodies, rapidly combining with the iron to form oxide of iron and penetrating to every part of the molten bath almost simultaneously, reacts with great violence upon the impurities, forming silica with the silicon and carbonic oxide with the carbon, the carbonic oxide escapes as a gas and the silica forms silicate of iron with the oxide of iron and rises to the surface as a slag, the manganese in like manner enters the slag as manganese oxide. By this means 10 tons of pig-iron can be converted to practically pure iron in ten to fifteen minutes by the Bessemer process.

If phosphorus is present in the pig-iron it will tend to form iron phosphate, but as this body cannot exist at the temperature of molten steel it is immediately decomposed again, and the phosphorus re-enters the iron with the net result that at the end of the operation the phosphorus still remains in the steel, making it brittle and unfit for use.

Pig-iron made from Cleveland ironstone contains 1.5 per cent. phosphorus, and it is therefore impossible to convert it into steel by the original Bessemer process.

The Basic Bessemer.—Thomas and Gilchrist modified the Bessemer process by adding at the conclusion of the blow about 4 cwts. of burnt lime for each ton of iron in the converter and continuing the blowing for a few minutes after the addition of the lime. The lime had the effect of itself causing the decomposition of the iron phosphate and combining with the phosphoric acid to form phosphate of lime, a compound which is stable at the temperature of molten steel.

This change in the process made it necessary to conduct the operation in a vessel lined with burnt dolomite mixed with tar as a temporary binder until sufficient heat had developed to cause the lining to frit together. Lime, brought into contact with a lining of ground silicious rock as used in the original Bessemer process, would, upon heating, immediately have attacked the silica lining and utterly destroyed it in a few minutes. Indeed, the experimental part of the work of Thomas and Gilchrist was as considerable in finding a suitable lining, as it is the main idea, of making the slag chemically basic by the addition of lime.

The invention of the Basic Bessemer Process opened up an enormous field in steelmaking from the native ores of this country, which without its aid would have hampered greatly the industrial activities of the nation, and particularly of the Cleveland district.

The Siemens Open-Hearth Process.—This is a direct descendant of the old puddling process. A reverberatory furnace is an inefficient heating apparatus, and it was early recognised that a purer and more reliable material could be made from pig-iron if the temperature could be maintained sufficiently high to retain the metal in the furnace in the molten state, in spite of its melting point becoming higher as it approached the condition of pure iron. The necessary high temperature to do this could not be reached in a large furnace until Siemens developed a principle of heating which enormously increased the efficiency of the fuel. Siemens' invention of the gas producer and the regenerative principle was so successful in reaching its main object that the difficulty no longer was to reach a sufficiently high temperature, but to get a refractory brick able to withstand the temperatures his discoveries had made possible, and this limitation still exists. When coal is heated in a vessel having only one exit about 10,000 cu. ft. of gas are evolved for every ton of coal treated, but there remains behind about 70 per cent. of the original weight of the fuel; the gas made is of high calorific value, of the character used in towns for domestic use. If air is blown into the bottom of such a vessel in limited amount, just sufficient to burn the coke to carbon monoxide, the whole of the coke is consumed and the coal entirely converted into gas, except the inorganic mineral matter or ash. So high a temperature is developed, however, that no firebrick would stand. To overcome this difficulty Siemens introduced a small quantity of steam with the air; the steam became decomposed into hydrogen and oxygen, and in changing its state absorbed heat and cooled down the vessel or producer, and so provided a means of controlling the temperature of operation by varying the steam admitted. At the same time, the hydrogen formed enriched the gas, and a large portion of the heat used in decomposing the steam was liberated again in the furnace by burning the gas with the reformation of steam. The calorific value of producer gas is only about one-third that of gas from the plain distillation of coal, but its volume has increased from 10,000 to 150,000 cu. ft. per ton of coal burnt. Having thus a source of gas, Siemens burnt this in a furnace, but instead of allowing the products of combustion to pass away into the stack at a high temperature as in the reverberatory furnace, he caused the products to pass through two chambers filled with brickwork chequering, which, by absorbing the heat of the waste gases, acts as an accumulator. By a system of valves the direction of the producer gas is reversed, and the combustible gas passing through one chamber and the air for the combustion of the gas through another, the two streams meet in the melting chamber or hearth, and, burning, create, in virtue of the regeneration of the waste products, a temperature of far greater intensity than would be possible by means of the unregenerated gas and air.

Having now at command an apparatus for the production of high temperatures in large furnaces, it became possible to extend the usefulness of the old puddling process. In the open-hearth

process the pig-iron, either solid or molten, together with steel scrap, is charged on to the hearth of a regenerative Siemens furnace, and, instead of the air used in the Bessemer process to burn out or oxidise the impurities, iron oxide in the form of ore is added. The oxygen of the ore combines first with the silicon and manganese to form a silicate slag. The continued addition of the ore maintains on the surface of the bath a slag which is highly oxidising, so that when melting is complete all the impurities in the pig-iron have been eliminated excepting only the carbon. With the increasing temperature in the furnace a curious effect is observed on the surface of the bath, which becomes covered with bubbles of gas breaking through the slag and burning with a bluish flame. This is the period known as the "boil," during which the carbon is removed as carbonic oxide and burns at the surface of the bath to carbon dioxide, giving rise to a characteristic bluish flame. The liberation of this gas takes place in the molten bath through contact between the oxide of iron dissolved in the slag and carbon in the metal. The evolution of gas agitates the bath and carries down the slag into the metal, until the ebullition is so violent as to project the metal and slag well above the surface when the action is at its height. As the carbon is burnt out the action gradually subsides, and the additions of ore are discontinued so as to allow the oxide in the slag to become exhausted and the slag to acquire as neutral a character as possible before the final tapping of the steel. It is the principal function of the smelter to judge, by the fluidity of the slag and the temperature of the furnace, when he has reached a condition such that the oxide in the slag is at a minimum and, coincidently, the carbon has been reduced to the required content in the steel. In this condition the steel is said to be dead-melted, and no steel can be of the highest quality which has not been so finished. It is especially the ease with which steel made in crucibles can be brought to this dead-melted state and held there for a time that has given crucible steel its well-known reputation for high quality. It is not possible in the open-hearth furnace to reach that state of thorough deoxidation which can be attained in a small crucible closed by a lid, since a considerable amount of the oxygen required for refining does not come from the ore, but comes from the excess of air used to burn the gas in the furnace. This excess of air provides a constant source of oxygen, which enters into chemical combination with the slag and prevents so thorough a dead-melting being reached, for with each increase in the concentration of oxygen in the slag a further portion of oxide of iron dissolves in the steel bath, until chemical equilibrium is again restored.

It is probable that sulphur and phosphorus, the so-called "diabolical" elements in steel, have more often been blamed for inferior quality which was due to bad melting than for any disadvantage arising from small increases of these elements. Steel made in the electric furnace possesses no inherent advantage over open-hearth steel save the important one here dealt with—that its source of heat permits an atmosphere almost free from oxygen to be maintained in the furnace during the finishing stages, and, as a consequence, steel so made is capable of giving results which rival those hitherto produced only in the crucible process. For a quite similar reason open-hearth steel is superior in general to Bessemer steel, since the process is more under control and the condition of the bath capable of being adjusted with greater accuracy.

In spite of the greatest precautions, steel tapped from the furnace or converter contains sufficient oxide of iron dissolved in it to make it unworkable under hammer or rolls. In extreme cases it falls to pieces, so incoherent is it made by the contained oxide. The Bessemer process, splendid as it was in conception, was a complete failure as a means of making steel until Robert Heath, profiting by experience in the crucible process, added manganese in the form of spiegeleisen to the molten steel, and found that the steel so treated could be rolled, hammered, or welded with the greatest of ease.

Valves for Internal Combustion Engines.*

BY J. DAVIES PITT, A.M.I.M.E., M.I.A.E.

There is some diversity of opinion regarding the most suitable steel for valves in an internal combustion engine, and in the early stages of the great war many different alloy steels were experimented with to find the most suitable steels for the various types of engines.

The writer refers chiefly to high-speed engines for aviation, fast motor boat engines, and engines that work for long periods at full load. For air-cooled aero-engines the experiments and tests proved that the most suitable steels for exhaust valves were 25 per cent. nickel steel and 11 per cent. tungsten steel, and for induction valves 3½ per cent. nickel valve steel. These engines ran comparatively slowly, *i.e.*, the maximum revolutions per minute rarely exceeded 1,800.

The stresses, therefore, in the valve stems due to acceleration of the valve were not of serious moment, but as the aeroplane developed and called for higher speed (2,500-3,000 r.p.m.) and higher power engines, mostly of the water-cooled type, designers had to find a steel for valves that would stand the higher acceleration stresses and not "pit" or distort. In a great many cases 11 per cent. tungsten steel was used with complete success, but in most cases designers adopted the 13 per cent. chromium or rustless steel.

A great deal of trouble was experienced in producing satisfactory stampings in 25 per cent. nickel, 11 per cent. tungsten and 13 per cent. chromium steels, and in a large number of cases the heads of the valves came off in work owing to two causes:—(*a*) The steel having been overheated to facilitate production; (*b*) working the steel at too low a temperature.

As is well known, the early operation of stamping a valve is to swage the stem down. The last operation is to form the head of the valve. It will be apparent that the small stem will cool much quicker than the head portion. It is therefore important that the stem should be in a plastic state for the heading operation, otherwise there will be a "cold close" where the stem joins the head, and the head will drop off when the valve is called upon for heavy duty. Even to-day a number of stampers find serious trouble in stamping the three alloy steels mentioned. The writer is of opinion that most faulty valve stampings are caused by working the steel at too low a temperature.

Another source of trouble is the heat-treatment of valves. The following notes on the heat-treatment will perhaps be of interest:—

25 per cent. nickel steel should be normalised at 880-900 deg. C. No further treatment is necessary.

13-18 per cent. tungsten valves should be heated to 950 deg. C. and cooled in still air, then re-heated to 800 deg. C. and cooled in still air before machining.

13 per cent. chromium valves should be heated to 900 deg. C. and cooled in oil, then re-heated to 700 deg. C. and cooled in still air before machining.

Although much is to be said in favour of valves in the above alloys, and in most cases it is absolutely necessary to use such steels for high-speed aero-engines, a careful study of the stresses in valves in a modern motor car engine or commercial vehicle will reveal the fact that it is not necessary to employ such expensive steels.

The "Mecca" of a great number of designers in doubt as to the most suitable steel to overcome their troubles appears to be 13 per cent. chromium, whereas, in most cases, a 3½ per cent. nickel steel will fulfil all the conditions called for in the modern motor-car engine. The advantages are:—(1) Lower initial cost of steel; (2) more uniform and reliable stampings and reduction in scrap; (3) simplicity of heat treatment; (4) easier to machine; (5) ends can be case hardened if necessary; (6) no warping of head or pitting of seat.

With regard to heat-treatment of 3½ per cent. nickel, this should be normalised at 830-850 deg. C. No further treatment is necessary.

* Extracted from the Edgar Allen News.

Some Properties of 60 : 40 Brass.—Part I.*

By Cecil H. Lesch.

The brasses used in engineering may be divided into two main groups, one of which is typically represented by the alloy containing 70 per cent. of copper and 30 per cent. of zinc, often known as cartridge brass, and the other by the 60: 40 alloy. Alloys of the former class are composed of a single homogeneous solid solution, the α-constituent, and their most valuable characteristic is their great ductility, enabling them to undergo severe cold-working without cracking. On the other hand, the typical alloys of this class cannot be rolled at a red heat without great difficulty. The second class includes alloys with a duplex structure, the α-constituent of cartridge brass being accompanied by a second or β solid solution. The proportion of β increases from zero to unity as the percentage of zinc is increased from 36.5 to 46.5. This constituent has the property of being very plastic at high temperatures. Moreover, the ratio of β to α increases with the temperature, the normal ratio being restored on sufficiently slow cooling to the ordinary temperature. This property of plasticity makes it possible to shape the alloys which have a duplex structure by rolling, hot stamping, or extruding at or above a red heat, and rolled or extruded bars find many applications in engineering workshops. When cold, such bars are readily machined.

In the course of using very large quantities of brass of approximately 60: 40 composition in processes which involved many turning and drilling operations on automatic lathes, it was found that rods supplied by different manufacturers gave widely differing results in the machine shops. In one instance a change from one brand of brass to another, nominally of the same character and composition, led to a drop of 40 per cent. in the output from the automatic lathes, whilst at the same time the wear on the tools was so greatly increased as to reduce their average life to one-fourth of its former value. The present investigation was undertaken with the object of throwing some light on the cause of such remarkable differences. A selection from the results has been made, and the present Paper contains data relating to rods from sixteen different manufacturers.

The composition of brass of this class always departs more or less from the nominal standard of 60 per cent. copper and 40 per cent. zinc, owing to accidental variations in the manufacture and to the presence of small quantities of other metals. A certain amount of lead is almost invariably added, with the object of improving the machining qualities; iron is usually present as an impurity; manganese or aluminium is frequently added as a deoxidiser when casting; and tin or nickel is sometimes added with the object of increasing the strength of the alloy. The rather high percentage of some of these metals in a few cases is no doubt to be attributed to the use of scrap in making the billets from which the bars have been rolled or extruded. The composition of the alloys used is given in Table 1, the numbers in the first column being laboratory numbers, which are repeated throughout for reference. It should be stated that the zinc in all the analyses has been determined by difference. A few bars of exceptional composition have been included, as they were supplied to meet the same specification as the remainder, and they indicate the variations which are liable to occur in the supplies of metals which are nominally of the same composition.

When the proportion of one of the metals mentioned above does not exceed a certain limit it does not alter the essential characteristics of the $\alpha\beta$ brass, but is taken into solid solution, chiefly in the β constituent. When a larger proportion is present a third constituent makes its appearance, but no such separation has been observed in any of the alloys examined in the course of the present investigation, showing that the limits of saturation of the solid solutions were not exceeded. An exception must be made in the case of lead, which is visible in minute isolated globules in those specimens which contain a high proportion of that metal. A certain influence is, however, exerted on the structure by the presence of these foreign metals, since each metal, in passing into solid solution, has the same effect as a definite quantity of zinc. The structure of a complex alloy of this class is therefore the same as that of a pure copper-zinc alloy containing a somewhat different percentage of zinc. For many purposes, it is desirable to know the composition of the pure alloy which is identical in structure with the alloy under examination. Coefficients of equivalence have been determined, 1 per cent. of tin, for example, having the same effect on the structure as 2 per cent. of zinc. The other equivalents are:—Aluminium, 6; tin, 2; lead, 1; iron, 0.9; and manganese, 0.5.[1]

TABLE I.

No.	Cu.	Zn.	Sn.	Fe.	Pb.	Mn.	Al.	Ni.	Apparent Zn.
351	60.02	39.57	0.13	0.03	0.23	—	—	—	40.04
352	59.98	39.50	0.13	0.04	0.31	—	—	—	40.07
609	59.92	37.84	tr.	0.08	1.99	—	—	0.17	40.0
610	59.79	38.83	0.62	0.12	0.64	—	—	—	40.5
611	60.04	39.21	tr.	0.13	0.62	—	—	—	40.0
612	55.17	44.04	tr.	0.10	0.61	0.08	—	—	44.8
613	59.27	39.00	0.06	0.15	1.47	—	0.05	—	40.9
614	57.97	39.66	0.15	0.14	1.95	0.04	0.09	tr.	42.3
615	56.97	40.50	0.07	0.12	1.95	—	0.20	0.19	43.6
616	56.62	40.19	0.49	0.35	1.89	0.11	0.31	0.04	44.6
617	59.82	38.86	0.23	0.25	0.78	—	0.06	—	40.5
618	60.01	38.39	tr.	0.06	1.54	—	—	—	40.0
619	57.95	40.72	0.07	0.27	0.89	—	0.06	—	42.1
622	58.29	40.23	0.32	0.50	0.66	—	—	—	41.7
623	56.56	40.98	tr.	0.32	0.99	1.02	0.13	—	43.5
694	64.13	34.67	0.49	0.49	0.09	0.07	0.06	—	36.3
712	49.16	49.78	—	0.07	0.99	—	tr.	—	50.8

Representing the coefficient of equivalence of an element by t, and its percentage in a given alloy by q, we may calculate the "apparent" percentage of copper in the brass, that is, the percentage of copper which would be contained in a pure copper-zinc alloy of identical structure, by means of a formula.

$$B' = \frac{(B + tq)\,100}{A + B + tq}$$

where B′ is the "apparent" percentage of zinc, B the actual percentage of zinc, and A the actual percentage of copper in the alloy. Should the alloy contain more than one added metal, the value of tq is calculated separately for each, and the sum Σtq is inserted in the formula. The values so calculated have been inserted in the table. As an example of this, it will be seen that No. 612, containing 44.04 per cent. of zinc, has almost exactly the same structure as No. 616, which only contains 40.09 per cent. of zinc, the percentages of apparent

* A paper recently read before a joint meeting of the Sheffield Branch of the Institution of British Foundrymen, the Sheffield Section of the Institute of Metals and the Sheffield Society of Engineers and Metallurgists.

[1] L. Guillet, Rev. Mét., 1906, 31, 243.

zinc being 44.6 and 44.8, the latter value being raised by the added metals, aluminium especially, on account of its high coefficient, having a very great influence. As might be expected from a consideration of the microscopic structure, the mechanical properties are found to correspond more closely with the apparent than with the actual zinc percentage.

The photo-micrographs shown in the figures represent longitudinal sections cut from bars mostly of 2.4 in diameter. The sections have been etched with an acid solution of ferric chloride, so that the β constituent appears dark and the α light. The size of the β grains is determined by the conditions of cooling in the higher range of temperature, all these alloys being composed solely of β immediately after solidification, whilst the crystals of α separate at a lower temperature, and their arrangement is mainly determined by the conditions of temperature distribution during the process of extrusion or rolling. Whilst the differences of structure between different bars are often strongly marked, it has not been found possible to distinguish the products of one works or even of one manufacturing process from those of another, as equally great differences may be found between bars made from successive ingots in the same casting shop, or even, in certain cases, between bars successively extruded from the same ingot. In the process of extrusion, the temperature falls considerably during the passage of the bar through the die, and the difference between the temperature at which the front end of the bar issues from the press and that at which the last portion emerges may, when the speed of extrusion happens to be rather slow, amount to as much as 100 deg. C. Microscopical examination then shows two widely differing structures in different parts of the same bar. The outer and inner portions of a bar at the same cross section may also differ considerably in size of grain, but it has been observed that the most fibrous bars, such as No. 618, are practically uniform throughout their section. It may be said that bars from those makers who were most successful in meeting the requirements of the machine shop were the most uniform in structure, so that bars from different consignments showed very little variation.

There is at present no satisfactory test by means of which the machining quality of a brass may be determined other than that of the workshop, and this test is only conclusive when continued over a long time, and with a large quantity of metal, in order to eliminate accidental variations in the sharpness of the tools, etc. It is shown below that tests of hardness in the ordinary sense, as revealed by the Brinell or similar methods, are of no value in determining the hardness of a brass towards a cutting tool. It was therefore thought advisable to use a workshop tool under conditions which could be easily regulated, and for this purpose a drill was selected. The machine used was a vertical, belt-driven drilling machine, from which the feeding arrangement had been removed and replaced by a lever, to the end of which was attached a quadrant, carrying a weight by means of a cord. The depth of the hole to be drilled was fixed by means of a collar attached to the vertical spindle. The bar to be tested was marked with a centre punch and placed in the vice immediately under the drill. The lever was raised to a definite angle and the height adjusted. The drill was then started, and the time taken to drill a hole to a depth of 1 cm. was noted with a stop watch. Each test was repeated, the values so obtained being very concordant. Three series of tests were made, the first and third using a $\frac{1}{2}$ in. twist drill at a speed of 300 revs. per minute, and the second with a $\frac{3}{8}$ in. drill at a speed of 700 revs. Fifteen bars were tested in this way. The first series showed a general increase in the time of drilling with increasing zinc, but the points did not fall at all regularly about any curve. The second series, at the higher speed, gave still more irregular results, and this was found to be due to the rapid blunting of the tool. The bars containing a high proportion of the β constituent were conspicuously hard when tested at the high speed, Nos. 612, 616, and 623 taking more than ten times as long to drill as the softest bars. The order of hardness of a series of brasses in a machining test depends largely on the speed of drilling, the angle to which the drill is ground, and the condition of its edge. (These factors have been carefully investigated for the case of steel by A. Kessner.[2]) The fine-grained brasses gave uniformly the best results at a high speed, but the figures have not been included in the table.

In the third series of tests, reverting to the slower speed and larger drill, and using certain added precautions, the conditions were more favourable. Drilling was more rapid, and possible errors due to the blunting of the drill were eliminated by testing bar No. 618, which had proved to be the best, at the beginning, middle, and end of the series, identical figures being obtained in each case. The results are shown in Table 2 and are plotted in Fig. 1.

Table II.

No.		Machining time in seconds. Third series.
609	Extruded	27
610	Rolled	40
611	Rolled	38
612	Extruded	45
613	Extruded	29
614	Extruded	27
615	Cast	30
616	Extruded	28
617	Rolled	40
618	Extruded	25
619	Extruded	43
622	Cast	31
623	Extruded	40

It will be seen from the figure that whilst no single curve can be drawn through the points, they group themselves, on the whole, into two sets, each lying near to a line which rises with increasing zinc content. In one of these sets the machining times are all above 35 secs. and in the other all below. The softer bars include the two cast specimens and five extruded bars. The harder set includes three rolled bars and three extruded bars, two of which were abnormally high in zinc and therefore contained an undue proportion of the relatively hard β constituent. The bars obtained by extrusion which have a normal structure fall into the softer group.

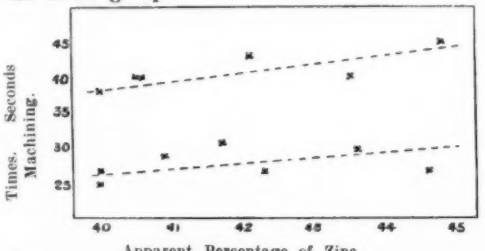

Fig. 1.—Showing the Influence of Zinc on the Machining Properties of Brass

Remarkable differences in the appearance of the drillings were observed. Owing to the rapid blunting of the tool, the appearance of the drillings obtained at a high speed was less characteristic than in the other cases, but it was found that Nos. 611, 617, and 618, which have a fibrous structure, yielded long spiral drillings even at the higher speed. In the third series the longest spirals were given by Nos. 610 and 617. The cast alloy, No. 615, gave exceptionally light and feathery short drillings in all the tests that were made. The character of the drillings in the third series is shown in Table 3, the percentage of lead being also indicated, since the presence of lead is known to favour the formation of short drillings. The table shows that spirals are formed from the bars containing less than 1 per cent. of lead and short drillings from those which contain a larger proportion, the only exceptions being No. 612, which is high in zinc, and No. 622, the reason for which is not obvious.

Table III.

Short borings.	Short spirals.	Long spirals.
609..1.99% Pb.	611..0.62% Pb.	610..0.64% Pb.
612..0.61	619..0.89	617..0.78
613..1.47	623..0.99	
614..1.95		
615..1.95		
616..1.89		
618..1.54		
622..0.66		

(To be continued.)

[2] Iron and Steel Inst., Carnegie Mem., 1913, 5, 10.

Institution of British Foundrymen.

SHEFFIELD BRANCH.

Discussion on Mr. MacGuffie's Paper on the Manufacture of Steel Castings.

THE CHAIRMAN (Mr. A. Hyde) said that Mr. MacGuffie had gone into the subject very thoroughly, and he had touched upon many points which had an interest for them. It did not matter where they looked—whether in this country, America or the Continent—foundrymen had the same troubles. Mr. MacGuffie had referred three times to the importance of the man in charge. That was undoubtedly an important factor, and it really applied to everyone in the trade. Men were required who would take a live interest in their work. He would like to ask the lecturer whether he considered green-sand moulds were found to contract more than dry-sand moulds. Were they going to measure 3-16ths or a quarter on contraction? He took it that Mr. MacGuffie would advise them to make the patterns big enough to permit of the casting being machined down. Then there was the point of the advantage of the electric furnace owing to the low sulphur content which was obtainable. He would like to know if the sulphur content had any influence on the steel castings. Another point he would like to refer to was Mr. MacGuffiie's great opinion of the Stock converter. He would like to know if Mr. MacGuffie had regarded it in the commercial light—had he considered the high price of oil and charging?

MR. DARLEY said there was no doubt a good pure steel could be obtained from the electric furnace, but it very quickly lost its heat, resulting in ladle skulls. With regard to the Stock furnaces, he thought it was excellent for making light castings, but the cost of oil, repairs and upkeep were too high to render it economical. He regarded tests as useless in this case, as it was merely a question of raw materials.

MR. J. FERDINAND KAYSER said that he disagreed with everything that the lecturer had said on the metallurgical side of the question. The microstructures shown, for instance, were not, in his opinion, at all characteristic of the stated treatments, and the particulars given of treatment were so scanty as to make them worthless. With regard to the oxidation during the blowing of a charge in the Tropenas process, he thought that the lecturer was quite wrong in stating that there was a stage in which first carbon was burnt, then silicon, and then more carbon. He thought it was generally agreed that first the manganese was burnt out, followed out by the silicon, which was the chief heating agent in the blowing process, and lastly the carbon.

Mention was also made of the brown flame due to the burning of the carbon monoxide. Surely, everybody knew that carbon monoxide burnt with a blue flame.

MR. BRADLEY asked if Mr. MacGuffie found any difference in the contraction of the electrical steel, as he thought that that would probably account for the contraction in the steel disc mentioned by the lecturer.

MR. MACGUFFIE, in a general reply, said that he had not stated that the electric furnace was any better than any other. It depended upon the class of work for which it was required, but taking it all round, it constituted a satisfactory plant.

COMMANDER JACKSON, in proposing a vote of thanks to Mr. MacGuffie, said that most of the foundry troubles originated in the furnaces. It did not appear to him to be so much in the moulding as in the making of the steel that most of the failures occurred.

MR. SHAW seconded the vote, to which Mr. MacGuffie suitably replied

LONDON BRANCH.

Discussion on Mr. MacGuffie's Paper on the Manufacture of Steel Castings.

THE CHAIRMAN (Mr. H. Slater), in opening the discussion, expressed his thanks to the author for the manner in which he had dealt with many of the difficulties connected with the foundry. He would like to know what Mr. MacGuffie used to prevent cracking, such as brackets and other methods. Undoubtedly the lecturer had certainly pointed out some difficulties which it was possible to fall into in foundry work. He was very much indebted to the author for some of the practical remarks he had made with regard to moulding. He would like to ask the lecturer what weight of steel he would cast, using green sand. He asked the author what method he used for stopping castings of unequal sections cracking, both with cores and the mould itself.

MR. V. C. FAULKNER proposed a vote of thanks to the author for his interesting lecture, and said he disagreed with most of the author's metallurgical conclusions. With the electric furnace, the author said that carbon monoxide burned outside the furnace with a brown flame, whereas it burned with a blue flame. As a matter of fact, it was the volatilisation of the iron oxide on the scrap—the rust—which gave the brown flame, and not carbon monoxide. In speaking of electric furnaces, the author had not said that there were two or three distinct grades. There was as great a difference between an induction furnace and an arc furnace as there was between a Stock converter and a crucible furnace.

MR. C. F. WALKER said he would very much like to produce a small steel casting in green sand with the crucible process, and asked what sand should be used with a mixture of, say, 100 lbs., to make a mild steel casting.

MR. T. D. ROBERTSON referred to the occasion on which the author gave his lecture in Sheffield, when it was alleged by one speaker that electric steel lost its heat somewhat more quickly than steels made by other processes. He did not agree with that remark, and he knew of a case within his own experience where, with a 2½-ton electric furnace, no less than 120 different boxes were cast by means of a ladle having the stopper and nozzle method of pouring—*i.e.*, a crane carried the ladle over 120 boxes and poured the steel in each, the stopper opening and closing in the ordinary manner. That was quite a good performance, and if electric steel would remain fluid sufficiently long to pour 120 boxes, it was fair to say that it would keep its heat as long as steel made by other processes. Again, with a 3-ton electric furnace installed in Italy, with the steel-melting equipment situated in a different part of the works from the foundry, the steel was poured out of the furnace into the ladle, which was put on a small car, drawn by donkeys to a distance of about 200 yards into the foundry, where it was picked up and poured into a large number of small castings. That was another indication that electric steel suffered no disability in respect of keeping its heat. Mr. MacGuffie had emphasised stopper and nozzle troubles in connection with electric steel rather than steels made from other processes. His opinion was that any trouble experienced with stoppers and nozzles in pouring steel were simply and solely a function of the temperature of the steel as it was poured into the ladle, and had not anything to do with the particular process by which it was made. The author had also said that the electric furnace might be considered to be in its infancy. If that remark had been made about six or seven years ago, he thought they would all have agreed, but at the present time there were between 800 and 1,000 electric steel-making furnaces installed in different parts of the world, which have a total annual production somewhere in the region of 1,000,000 tons of liquid steel per year. Coming to the question of what particular process for making steel should be adopted—a question to be faced by all steel makers at one time or another—the author had described the essentials of the various processes used in this country at the present time, and gave the good and bad points of all. Holding a brief, as he did, for the electric furnace, however, he would like to say that at present it was becoming more and more difficult to get a high-grade pig-iron suitable for the Tropenas plant or the Stock converter in order to make castings to meet present-

day specifications. Pig-iron low in sulphur and phosphorus had to be chosen. As against that, the electric furnace was capable of melting any sort of steel scrap on the market. In the basic electric furnace the phosphorus in the scrap could be reduced to almost negligible quantities, and when carrying out the ordinary steel-making processes the sulphur was automatically reduced as the steel was de-oxidised and purified ready for teeming, so that one could start with inferior and cheap raw materials, and produce a steel of a chemical analysis and physical properties that would meet any specification for steel castings. The cost of these special pig-irons was very high indeed, but the cost of steel scrap had come down a great deal lately, and at the present time there was no doubt that making steel for steel castings in the electric furnace, given normal conditions and price for the supply of power, was cheaper than any converter process. A few years ago he had seen a large number of the best equipped American steel foundries, and one thing which struck him more forcibly than anything else was the special attention, and the large amount of floor space, devoted to the dressing of the castings. That was the big difference between the American steel foundries and those in this country. In America, in almost every foundry there was more floor space, more plant, and more tools allocated to the dressing, fettling, etc., of the castings than to the moulding itself, and if English steel-makers would bring their methods of dressing more up-to-date they would be able to put on the market a product more acceptable all round, and cheaper.

Mr. A. Willis, who seconded the vote of thanks, said the Paper was a practical, detailed explanation of the methods of producing steel castings in the foundry, and those who were engaged in that work must have learned a great deal from the practical information which had been given them by the author.

Mr. MacGuffie, replying to the point raised with regard to the addition of ferro-silicon and the size of the furnace, said he was speaking of a 3-ton furnace. As regards carbon-monoxide burning outside the electric furnace with a brown flame, he did not care what furnace it was, whether an electric, Tropens, Siemens, or any other, there was always an indication of a brown flame.

Replying to Mr. Walker, the lecturer stated that ordinary steel castings from crucibles were generally made from "punchings." A reliable silica sand could be obtained mixed up with a small amount of good fireclay, or even the French, Belgian, or Yorkshire sand, which would all cast green sand castings. Replying to the Chairman, he said the maximum weight that could be cast in green sand was 8 or 9 cwts., and that it was not advisable to run a casting with thick and thin places in the thick place.

COVENTRY BRANCH.

"Foundry Refractories (Facing Sands)."

At a meeting of the Coventry Branch, held on February 23, Mr. H. Winterton's Paper on "Foundry Refractories (Facing Sands)," which appeared in the February 3 issue of the Foundry Trade Journal, was repeated. After the lecture the following discussion took place.

The Chairman (Mr. Geo. E. Roberts) said that he was interested to know that the investigations made during the war had proved that British sand was quite as good as any other. He would like to emphasise the difficulties under which a jobbing foundry had to work as compared with the large shop manufacturing repetition castings for the use of its own particular departments. It was very expensive and difficult to make an ideal facing sand for every individual job. The subject of blackings would long remain a contentious question owing to varying shop conditions.

Mr. Ashmore inquired whether it was the usual practice in foundries to add coal-dust to the facing sand every day, and, if so, what happens to the coal-dust that was not actually, or its properties, lost by coming in contact with the molten metal? There must be large quantities of coal-dust used annually that apparently does not accomplish any work. What becomes of the coal-dust which was in the older sand?

Mr. Prickett asked if the lecturer had had any experience of the effect of sand on density, as he (Mr. Prickett) had made an experiment with sand on speed wheels that were giving trouble. After the teeth were cut in the rim those opposite the junction of the arms were slightly spongy. To overcome this he adopted the method of taking ordinary new red sand and placing it at the junction, in order that when the metal came in contact with the coal-dust in the facing sand it must necessarily maintain the temperature, or slightly raise it. On the other hand, the new red sand, having no coal-dust in it, the temperature would decrease more quickly and so equalise the solidification. Sound castings resulted, and this practice has been since successfully adhered to.

Mr. Whitworth said he knew of castings being made without facing sand or coal-dust. Several thousands were made, red sand being added to strengthen the bond. They weighed about 9 lbs., and machined well.

The Author's Reply.

Mr. H. Winterton, in reply, agreed with Mr. Harley that carbon was not soluble in water, and the question was one of specific gravity. He greatly appreciated Mr. Harley's reference to the definite measuring out of the different ingredients when mixing. Mr. Ashmore spoke about the coal-dust in old sand. A certain proportion of the coal-dust on the first day would be taken from the sand, which became less effective as time went on. In reply to Mr. Whitworth, what was required was a really good bituminous coal, with a fair proportion of volatiles, less than 10 per cent. ash, and the rest carbon. He did not want to set down a hard-and-fast rule with regard to figures.

The Chairman, who proposed a vote of thanks, said that at his works they had adopted means for measuring sand, coal-dust, etc., so that they were able to get a constant facing-sand mixture, and troubles had been reduced considerably.

INSTITUTION OF PRODUCTION ENGINEERS.—There was a large attendance at a meeting held at Cannon Street Hotel, London, on February 26, when it was decided to form an Institution of Production Engineers. Mr. Cecil F. Hammond, of Coventry, was elected to the chair. After Mr. Honer had briefly outlined the objects of the meeting, an animated and somewhat lengthy discussion of the possibilities of the Institution took place. Among those taking part in the discussion were Mr. R. Waring Brown, Coventry; Mr. J. D. Scaife, works manager, Messrs. Ransome & Marles Bearing Company; Mr. H. C. Armitage, Messrs. Austin Motor Company; Mr. Atkinson, London; Mr. Butler, Messrs. C. A. Vandervell & Company, Limited, Acton; and Mr. J. W. Whitaker, London. Affiliation was suggested with some other body; this policy, however, did not meet with the general approval of the meeting, and it was ultimately decided by a large majority to proceed with the formation of a separate Institution. In the meantime, it is requested that all interested, particularly those who wish to become members, will communicate with the Hon. Secretary, Mr. A. T. Davey, 6, St. James's Square, Holland Park, Kensington, **W.11.**

FRENCH PIPES FOR YEOVIL.—At a recent meeting of the Yeovil Town Council, the acceptance was recommended of a tender of Mr. A. G. Cloake, of London, for the supply of 12-in., 6-in., and 4-in. pipes, amounting to £2,852. The price was at the rate of £18 per ton. Alderman Petter asked what firm Mr. Cloake represented; and Alderman Matthews replied that it was a French firm. There were four English tenders for these pipes and everyone quoted exactly the same price. The Committee were convinced that all four were in a combine. Mr. Cloake was evidently outside, and quoted £5 2s. 6d. per ton less than the others for straight pipes, and £12 per ton for bends. Before recommending the acceptance of the tender, the consulting engineer and the borough surveyor went to the Tottenham Gas Works to see some specimens, and found they had given every satisfaction. The surveyor said the difference between the thickness of the French and English 6-in. and 12-in pipes was $\frac{1}{16}$in. This made a difference in the lengths per ton. They were also longer, and would be easier to lay, and there would be fewer joints to make. Alderman Petter thought they must adopt the recommendation, but suggested that, before the contract was definitely settled, the surveyor should make inquiry of the other firms to know if they would make a reduction in the contract. The resolution was carried.

Trade Talk.

MR. E. ADAMSON, of Sheffield, recently lectured before the Ipswich Engineering Society on "Malleable Cast Iron."

MR. A. C. WICKMAN will give a lecture before the Coventry Engineering Society on "Gauging and Fine Measurements" on March 18.

HERR HUGO STINNES is reported to have just bought the famous Alpine Montana Iron and Steel Works for the sum of approximately £1,500,000.

AT the Institution of Civil Engineers recently, a paper on "The Amritsar Hydro-electric Irrigation Installation" was read by Mr. Stephen Leggett.

THE annual general meeting of the National Federation of Iron and Steel Manufacturers will take place at the Savoy Hotel, London to-day (Thursday), March 17.

THE members of the Society of Engineers met in London on the 7th inst., when Mr. R. W. A. Brewer read a Paper on "Some Modern Engineering Practice in America."

THE erection of the new works for the Eastern Light Castings Company (India), Limited, is well in hand, and it is expected that they will be in operation in the course of 1921.

OWING to the fall in the price of metals, the Queensland Government is closing down the Chillagre silver, lead, and copper smelting works. Fifteen hundred employés are affected.

SIR P. LLOYD-GREAME stated in the House of Commons that the Report on light castings had been received and was now being printed. It would be published in a few days.

AT Sheffield, last week, Mr. J. Stead, of Steel, Peach & Tozer, Limited, addressed the members of the Society of Industrial Chemists on the relation of iron, carbon and phosphorus.

MESSRS. ARMSTRONG, WHITWORTH & COMPANY authorise a denial of a report which gained currency last week that the firm is about to amalgamate with Messrs. Vickers, Limited.

THE return of the trade of Swansea Harbour for the past year, just issued, shows a total trade of 4,326,254, compared with 4,431,521 tons in 1919, and 7,231,250 tons in the record year of 1913.

FOUR vessels, 19,460 tons in the aggregate, launched from the Wear shipyards during February, brings the output for the present year up to six vessels of an aggregate tonnage of 25,210.

A BRITISH trading company has been formed at Saarbrücken, under the title Britisches Handelskontor, for the purpose of importing and exporting mining and iron and steel and other products.

A GERMAN tender for a large plant for the Sheffield Corporation Electric Supply Department is by far the lowest. The figure is only £40,000, which compares with £100,000 the lowest British tender.

A MEETING of the Liverpool Engineering Society was held last week in the Royal Institution, Colquitt Street, when Mr. C. F. Farrington, A.M.I.Mech.E., M.Inst. Water E., read a paper on "Cowlyd Waterworks."

WAGES in the largest shipyards in New York are to be reduced by 10 per cent. as from April 1. It is explained that the reduction is due to the prevailing business slackness and the high costs of production.

RECENT developments of the Bengal Iron Company, Limited, include a large new blast furnace, which will materially increase the company's output capacity, and is expected to be in operation by December of this year.

THE ship joiners' strike at Southampton is having a disastrous effect on the port, which has lost another contract involving the expenditure of £60,000 in wages locally. The work has been transferred to Amsterdam.

ORDERS have been received holding up shipments on the 15,000 tons of pipe for the oil line from Havre to Paris, placed last fall with the U.S. Steel Corporation, but the ultimate carrying out of the contract is expected.

A GREAT meeting of business men with interests in Canada, held in London last week, decided to form a Canadian Chamber of Commerce in London. The movement was organised by the Agents-General of the four Provinces.

A STRIKE has broken out in the Luxemburg iron-mining districts of Differdange and Rodange, and at one place a blast furnace exploded owing to lack of attention. The men's leaders are trying to make the strike a general one.

AN address on "The Theory of Probability" was given by Professor Godfrey Thomson at a general meeting of the Graduate Section of the North-East Coast Institution of Engineers and Shipbuilders, in the Mining Institute, Newcastle.

ON Saturday the members of the Institution of British Foundrymen (Newcastle and District Branch) met at the Neville Hall, Newcastle-on-Tyne, to hear a Paper read by Mr. J. E. Hurst, of Mansfield, on "Some Notes on Centrifugal Castings."

ACCORDING to the American representative at the Leipzig Fair, the Copper Export Society, of New York, has entered into an agreement with Germany for the delivery of copper to the value of $42,000,000. The price approximates to 13 cents per English pound.

A MEETING of the employés of Messrs. Hawthorn, Leslie & Company, Limited, St. Peter's, was held at Byker, to consider the question of piecework in locomotive production, and after discussion a resolution was carried in favour of this method of working.

MESSRS. VICKERS, LIMITED, are opening a new sales office in Montreal in charge of Mr. R. S. Griffiths, formerly of Barrow-in-Furness, who will have charge in Canada of the sale of Vickers' hydraulic turbines and governors, oil engines, stone-crushing machinery.

ADVICES received from Pekin emphasise the growing tendency in the East to be self-dependent. In the case of the Shanghai mint to be constructed it is understood that a great portion of the plant will be built in China. This is indicative of the trend of things in India as well.

THE question of the amalgamation of the Tin and Sheet Millmen's Union with the Steel Trades Confederation has been under consideration for a considerable time. It is now arranged that the Tin and Sheet Millmen's Union members shall take a vote upon the matter.

AT a recent meeting of the London County Council the Special Committee on London Electricity Supply presented a scheme for submission to the Electricity Commissioners, providing for the constitution of a Joint Electricity Authority for the London and Home Counties District.

THE Imperial Mineral Resources Bureau in the annual report states:—The copper output in Canada has grown largely since 1913, and has got ahead of that of Australia. The building of the proposed railway line to Mount Oxide is expected to revive the copper mining industry in that State.

THE establishment of a new river line has been decided upon at a meeting of the Tees Conservancy Commissioners. This step has been rendered necessary by the erection of new works at Greatham Creek, and when the scheme is completed the Tees will have a navigable channel 1,000 ft. wide.

A SPECIAL meeting of the Executive Committee of the West of England and South Wales Iron, Metal and Waste Trade Association was held on the 3rd inst. at the Grand Hotel, Cardiff, Mr. F. G. Robbins presiding. Arrangements were made for the annual meeting and luncheon to be held at Bristol on April 6.

THE MARQUIS OF CREWE, retiring president, speaking at the annual general meeting of the Association of Technical Institutions, made a strong plea that educational progress should not be stinted, and he declared that it was legitimate to mortgage the future to a certain extent for educational purposes.

ALCOHOL from coke-oven gas for the propulsion of motor vehicles is now a practical proposition. How the experiment has proved a success was narrated at a meeting of the Cleveland Institution of Engineers held at Middlesbrough, on the 7th inst., by Mr. Cecil F. Tidman, Skinningrove Iron Company.

MUCH of the power generated in Arizona and New Mexico is derived from what was formerly wasted heat from reverberatory furnaces used to reduce low-grade ores in these States. This economy has made possible the mining of lower-grade ore than before, which has increased the output of the district and added to its wealth.

THE special sub-committee consisting of representatives of employers and employed to consider the proposed reductions in wages of boys and youths under 21 years of age engaged in the engineering and allied trades in Birmingham and district, held a further meeting last week. The question was discussed at considerable length, and a new schedule of rates was agreed upon.

THE Departmental (Home Office) Committee on Lighting of Factories and Workshops has now resumed its investigations. The Committee will for the present restrict its inquiries to the following points:—(1) The conditions necessary to secure suitable lighting in factories and workshops; and (2) the effects of mixed natural and artificial lighting, with special reference to the lighting of underground workrooms.

A LONDON local section of the Institute of Metals has just been formed. The chairman is Dr. O. F. Hudson, of the Admiralty Engineering Laboratory, and the honorary secretary is Mr. D. Hanson, M.Sc., of the National Physical Laboratory, Teddington. Membership is available to persons resident within 50 miles of the G.P.O. The first paper submitted before the London section was read on February 24 by Mr. O. W. Ellis, M.Sc., on "60:40 Brass." On March 31 Mr. S. L. Archbutt is to read a paper on "Aluminium Alloys," while on April 21 Dr. W. R. Ormandy will present a paper on "Refractories."

Company News.

Smith's Stamping, Limited.—Interim dividend of 1s. per share.

Thos. W. Ward, Limited.—Interim dividend on ordinary for past half-year of 5 per cent., free of tax.

The Mint, Birmingham, Limited.—Final dividend at rate of 6 per cent. per annum, less tax, on preference for six months ending March 31.

Baldwins, Limited.—The directors have declared an interim dividend, payable on April 7, of 2½ per cent., free of tax, on the ordinary shares for the half-year ended December 31, 1920.

Electrical & Industrial Investment Company, Limited.—Dividend of 6 per cent. on the preferred ordinary shares for the past year, carrying forward £21,028, subject to corporation profits tax.

Pearson & Knowles, Limited.—Half-year's dividend on first and second preference at rate of 6 and 6½ per cent. per annum respectively, also interim dividend of 5 per cent for half-year on ordinary, all less tax.

Radiation, Limited. — The report for 1920 shows, after bringing in £23,741, a balance of revenue account of £178,293. Directors recommend a final dividend of 3½ per cent. on ordinary shares, free of tax, carrying forward £40,754.

Delta Metal, Limited.—Report shows dividend of 5 per cent. and bonus of 5 per cent., free of tax, making 15 per cent. for year, £2,029 for depreciation, £32,469 to reserve for income and corporation taxes, £11,179 carried forward.

Archibald Arrol & Sons, Limited.—Net profit for year ended September 30 £47,105, after allowing £12,670 for depreciation and repairs. After payment of Debenture interest and including £17,176 brought in there is £50,939. Directors recommend no distribution until negotiations for dealing with arrears of preference dividend are concluded.

James Deakin & Sons, Limited.—The annual general meeting of the company was held at Sheffield last week, Mr. W. P. Deakin (the chairman) presiding. The directors reported the result of the trading for the financial year ending January 14 last, which was considered satisfactory. The accounts were approved and adopted, and a final dividend was declared at the rate of 7½ per cent. per annum, free of tax.

Monk Bridge Iron & Steel, Limited.—The net profits of the Monk Bridge Iron & Steel Company for 1918 were £65,968, and £18,285 was brought forward. A dividend of 6 per cent. was paid on the ordinary shares, £14,100 added to the depreciation fund, and £40,173 carried forward. Net profits for 1919 were £37,782, and a dividend of 6 per cent. was paid on the preference shares, and £4,396 added to the depreciation fund, £58,558 being carried over.

Leeds Forge, Limited.—At the annual meeting of this company on the 7th inst., Mr. Bernard Bagshawe, C.B.E., who presided, said the orders on hand for steel railway wagons and carriages showed a satisfactory increase over those of a year ago. There was almost a world-wide shortage of railway rolling stock, and it was certain that reductions in the cost of production would bring purchasers into the market. At the same time, owing to the exchange conditions, orders for types of railway rolling stock had gone to Continental competitors at lower prices than were possible to be quoted by British manufacturers. They proposed to constitute a new reserve fund and to make a first appropriation of £30,000. The profit for the year, after charging normal depreciation, and providing for E.P.D., was £130,337, which, added to the balance brought forward, made a total of £176,466 to be dealt with. A dividend of 7½ per cent., less tax, on the ordinary, was recommended. The report and balance sheet were adopted.

Personal.

Professor Conel William Long Alexander, Professor of Civil Engineering in University College, Cork, left personal property of the value of £3,766 7s. 7d.

Mr. Henry Arthur Fletcher, of Colwyn Bay, shipowner, who died on November 23, aged 60 years, left £33,015 18s., with net personalty £31,900 14s.

The late Mr. Jacob Higson, of Northwood, of Messrs. J. and P. Higson, civil and mining engineers, and director of the Mazapil Copper Company, Limited, left £56,926 (net personalty £54,887).

At the annual meeting of the Institution of Railway Signal Engineers, London, Mr. Charles H. Ellison, M.I.E.E., telegraph superintendent of the North-Eastern Railway, was elected president for the year 1921-1922.

Mr. J. Ellis (Past President of the Institution of British Foundrymen) has relinquished the position of foundry manager of Messrs. George Kent, Limited, Luton, to take up a similar position with the Palmer Foundry Company, Limited, Albion Works, Old Town, Clapham, London, S.W.4.

Deaths.

Mr. G. Hendry, ironfounder, St. Elmo, Bearsden, died suddenly in Glasgow on March 4.

Mr. J. McLachlan, of Bow, McLachlan & Company, Limited, Paisley, died recently at the age of 72.

Mr. F. C. Guest, Beeches Road, West Bromwich, whose death, after a lengthy illness, is announced, was the second son of the late Mr. Josiah Guest, J.P., founder of the Victoria and Albert Ironworks, West Bromwich, and was one of the partners of Josiah Guest & Sons, the proprietors of the works.

Mr. O. Winder, of Sheffield, died on the 8th inst. at the comparatively early age of 47. Mr. Winder, who had recently been appointed a local director of Thomas Firth & Sons, Limited, became associated with the firm during the war when he was Superintendent Engineer of the Yorkshire Area for the Ministry of Munitions.

Gazette.

Messrs. E. R. Hart and J. W. Orme, engineers, Blechynden, West Park Road, Southampton, trading under the style of W. W. Hart & Son, have dissolved partnership.

A winding-up order has been made against St. Anthony's Foundry, Limited, St. Anthony's Hill, Seaside, Eastbourne.

Messrs. F. E. Quick and J. D. Laurie, steel merchants, 89, Garden Street, Sheffield, trading under the style of the Sheffield Trading Company, have dissolved partnership.

It was resolved January 27 that the Intensive Machining Company, Limited, be wound up voluntarily. R. F. W. Fincham, 3, Warwick Court, Gray's Inn, W.C., C.A., was appointed liquidator.

It was resolved February 18 that Metric Engines, Limited, be wound up. T. D. Cocke, 44, Gresham Street, E.C., C.A., was appointed liquidator.

According to the monograph just issued by the Imperial Mineral Resources Bureau the utilisation of cobalt in the industries was until recent years restricted to its application in the form of smalt and other combinations of the metal, and the total amount used annually up to 1913 may be estimated roughly at about 200 tons. Its use as an alloy metal in recent years has increased the demand very largely. The world's annual production of cobalt oxide up to 1913 amounted to about 250 tons and has since increased, until, in 1915, it amounted to 350 tons or more, whilst the output of metallic cobalt, which was small in 1913, amounted to 152 tons in 1916 and 141 tons in 1917. In recent years Canada has been the chief producer. The annual report of the Department of Mines on the Mineral Production of Canada for 1918, gives the Canadian production of metallic cobalt as 196 tons, that of cobalt oxide as 512 tons, and that of other cobalt compounds as 83 tons. At the present time the principal cobalt deposits other than those of Cobalt in Ontario, are those of Katanga in the Belgian Congo; Schneeberg in Germany; Missouri, and the Blackbird district in Idaho, U.S.A.; and New Caledonia. The deposits in Ontario are the chief source of cobalt, and the silver refineries at Thorold and Deloro in Ontario have practically controlled the world's production in recent years

The men employed at the Wellington Foundry, Lincoln, have received a printed copy of correspondence that has passed between the owners—William Foster & Company, Limited—and a customer who, before the war, did business with the company for 30 years, and who asked for a quotation for maize-shelling sets for the South American market. A quotation was given, which Sir William Tritton, the managing director, says amounted to £14,000, of which £9,000 would have gone in local wages, and was based on only 6 per cent. profit. The customer said that American quotations were considerably lower, and while he would make some sacrifice for British goods, the price was prohibitive. A further difficulty was the strike clause, and a third the question of time of delivery, as to which Messrs. Foster said that working overtime under present Trade Union rules would add 12 per cent. to the wages bill. Sooner, however, than lose the order under present conditions they would pay half this amount, which would mean wiping out all remaining profit, if, to secure a fortnight's earlier delivery, the customer would pay the other half. The customer replied that acceptance was impossible.

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Pneumatic, Hydraulic, Jar Ramming, & Hand Power.

Type "A" Duplex Machine for Pneumatic Power.

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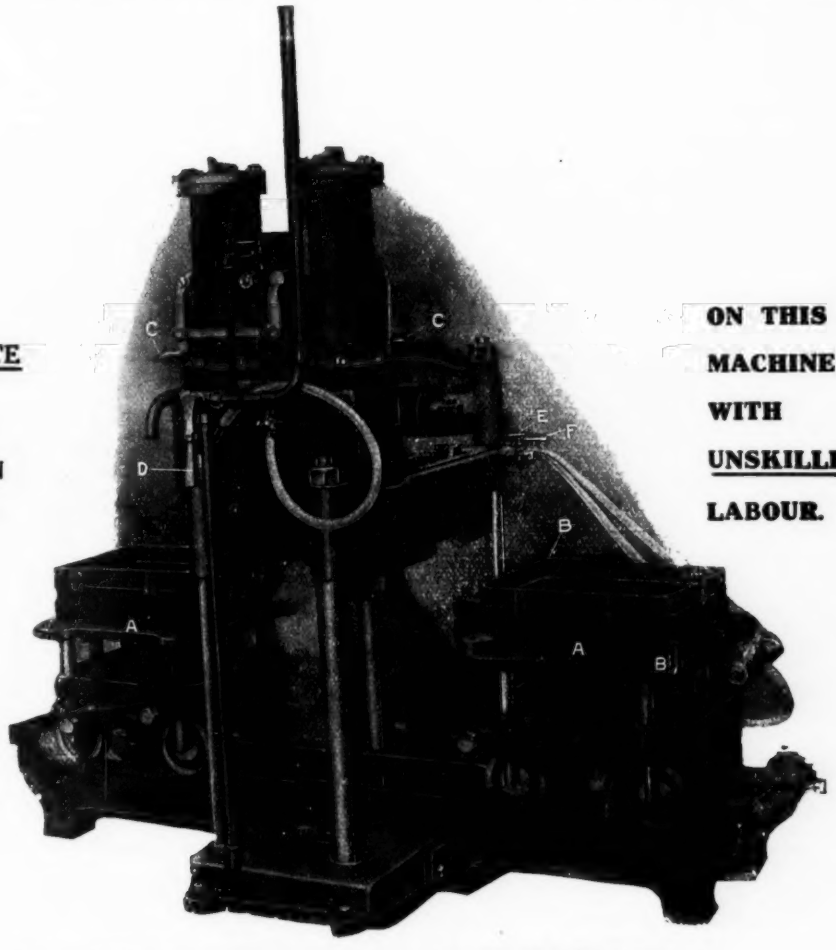

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IRON AND STEEL MARKETS.

Pig-Iron.

Contrary to general expectation, the action of the Cleveland ironmasters in making such a sensational cut in prices has not so far resulted in any marked improvement in business, pig-iron markets here, as elsewhere, continuing in the same stagnant mood as reported for some weeks past. There has, of course, been hardly sufficient time to gauge the actual effects of the decline on market movements, and with the near approach of Easter, and its prospect of extended holidays, it is scarcely surprising that consumers are still maintaining a cautious policy, while the uncertainty of future trade prospects continues to predominate. In the meantime, inquiries are still contracted within narrow limits, buying being chiefly of a hand-to-mouth order, with first-quarter contracts rapidly coming to a close, and Continental competition, as usual, in full force in home pig-iron markets. In Scotland, following the example set by Cleveland, prices for foundry pig have receded another 5s. to 12s. 6d., making with previous reductions a drop of about £4 from the highest boom levels, but still some 20s. per ton above quotations in April, 1919. In explanation of the present price position at Glasgow, as elsewhere, it must be admitted that costs of production all round are the sole factor in maintaining values at the present high levels, and until some substantial reductions in the wages and fuel bills can be effected it is practically hopeless to expect a return to a scale of quotations placing Scotch pig on a competitive basis with foreign imported metal. As exemplifying the extent of Continental encroachments in the home trade, it may be noted that the importations to Scotland last week amounted to 6,000 tons.

Scrap.

Business in all descriptions of scrap material continues for the time being without signs of animation, and in sympathy with the disorganised conditions of the pig-iron market, both sellers and buyers are abstaining from any but very occasional dealings. To such an extent has demoralisation proceeded that it is now exceedingly difficult to ascertain what actual prices are necessary to induce trading, the majority of foundries having already as much stock in hand as they consider prudent for near future requirements.

Steel.

The position in the steel industry remains depressed, and in view of the near approach of the Easter Holidays little hope of a change for the better can be entertained during the remainder of the current quarter. Reports received from Sheffield indicate that production has diminished to a scale unapproached for many years, the rolling mills working to a very limited capacity, while the forges are mostly idle. In the semi-steel departments, most of the makers have surplus stocks of billets and ingots on hand, while the inquiry for basic material has almost entirely ceased for the time being. Some Sheffield makers have still uncompleted orders on hand for railway tyres, axles and springs, but new business is very slow in coming forward. A reliable index to British steel conditions is supplied in the latest Board of Trade returns of overseas business showing exports of iron, steel and manufactures thereof in February to have reached 166,869 tons, or 66,000 tons below last January, and also of February of last year. In the same section imports are nearly on the level of January, but are double the volume of a year ago. We imported during the month 16,000 tons of steel billets from Belgium (none from Germany), 2,000 tons of steel ingots, and 11,000 tons of other descriptions of steel partly manufactured. Noteworthy items in the statistics are the importation of 23,000 tons of plates and sheets, 2,500 tons of constructional steel from Belgium, 3,000 tons of hoops and strip and 2,000 tons of tram rails

Finished Iron.

Reviewing the position in the finished iron trade at the moment, it is extremely difficult to discover any element of encouragement in the continued depression of the industry, and though some faint hopes were entertained of the result of the recent reduction in raw material values, it has to be regretfully admitted that so far they have not yet materialised. Veteran members of the trade with hard experience of previous bad times assert that nothing comparable with the present depression has been witnessed for many years, and though the marked bar manufacturers have, so far, escaped the worst consequences of the slump, other branches less fortunately situated have either restricted outputs or are considering the advisability of temporarily closing their works departments.

Refractories.

The demand for refractory materials since the commencement of this month shows a little improvement, though the demand is principally from the foundry trade.

The suspension of operations by various departments of many of the large steelworks is being felt considerably by refractories manufacturers. The crucible steel trade in the Sheffield district shows no change, and the demand for clays and crucible ganister in this district is, therefore, practically nil.

Prices of refractory materials remain constant as per the list published in our last issue.

Tinplates.

Although inquiries from the Continent and elsewhere are undoubtedly more frequent than of late, there is still a lack of animation in the tinplate trade, and any business offering is subject to eager competition by sellers in the market. Prompt sales have been done on the 25s. basis, but some makers still hold out for 30s. for fresh orders. It is stated that a good line of coke plates, 28 by 20, has been done at 55s. 6d. f.o.b. Wasters have been sold down to 20s. basis for 20 by 14, whilst quarter wasters have gone direct into consumption at 13s. 6d., f.o.b. Ternes are again lower, and makers' views are disposed to transacting business at the easier rates.

Furnace Coke.

Nothing fresh has transpired in connection with the coke position, demand having largely diminished owing to the closing down of so many blast furnaces and general slackness of industrial consumption. Consequently business in foundry coke is stagnant, and although some makers still hold out for top prices Durham qualities have been quoted at 50s. f.o.b. Middlesbrough.

Metals.

Copper.—Stimulated probably by the improvement in the financial outlook suggested by Budget disclosures, the market for copper opened under more active conditions than of late, and the general tone was distinctly cheerful. Holders of metal for near dates were evidently indisposed to press sales, and with only a quiet demand prompt cash showed a firmer tendency. Consumers are, however, only absorbing very limited supplies of metal, and prices underwent only fractional change.

Tin.—Saturday's Eastern advices notifying buyers at £160 10s., c.i.f., met with no response from sellers here in Monday's opening market, which, however, was marked with a steadier tendency, supported by the report that an agreement had been concluded between the Dutch-Indian Government and the Billiton Company with the Federated Malay Straits Government, whereby no tin supplies will be sold for at least three months. Subsequently markets experienced a sharp recovery, with an advance of prices in both positions, closing firm with cash £4, and three months £4 10s. better. English ingots, however, closed £3 10s. lower at £155. The weekly return of tin stocks in London warehouses shows a decrease of 63 tons to 4,763 tons.

Spelter.—With only a very restricted demand on consumer's account, market operations in spelter this week have been on a limited scale, but with some tendency to firmer rates. For ordinary brands buyers were quoting £26 15s., and the same for three months. English was marked £29; electro, 99.9 per cent., £34; remelted, £22 10s.; zinc dust, 92.94 per cent. nominal, £66 to £70; and ashes nominal, £6 5s.

Lead.—The market for lead was quiet, but firm, with considerably less selling pressure, and on balance good soft foreign prompt was quoted £19, and three months £19 to £19 7s. 6d. English was 10s. dearer at £20 10s.

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

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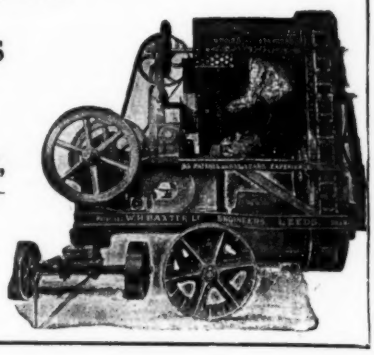

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DAVID COLVILLE

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Glengarnock Iron and Steel Works, GLENGARNOCK.
CLYDEBRIDGE STEEL WORKS, CAMBUSLANG.
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DALZELL STEEL — BOILER BRAND

PLATES, BARS, RAILS and JOISTS.

In Soft, Mild, Medium, High Tensile, H H Tensile, Nickel and Alloy Steel.

DALZELL STEEL — SHIP BRAND

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For { Fuel Economy, Efficient Control, Long Life of Pots.

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O. GOSSELL & SON, LTD.,

110, CANNON STREET, LONDON, E.C.

SPECIALITIES :—

RAILS, TRAM RAILS, STEEL SLEEPERS, STEEL JOISTS to 24 in. deep. CHANNELS, ANGLES, BARS, SHEARED PLATES, FLITCH PLATES to 36 in wide, &c.

BRIDGEWORK and CONSTRUCTIONAL IRONWORK.
SPECIAL STEEL CASTINGS. ROLLING STOCK.

Telephone No.:—CITY 6754. Telegraphic Address:—"GOSSOTTO, LONDON."

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	67	0	0
Three months	66	17	6
Electrolytic	70	0	0
Tough	67	0	0
Best selected	67	0	0
Sheets	114	0	0
India	114	0	0
Wire bars	70	10	0
Do. April	70	10	0
Do. May	70	10	0
Ingot bars	70	0	0
H.C. wire rods	78	0	0
Off. aver. cash, Feb.	71	0	9
Do. 3 mths., Feb.	70	14	10½
Do. Settlement Feb.	71	0	4½
Do. Electro, Feb.	76	15	6
Do. B.S., Feb.	75	1	10½
Aver. spot, copper, Feb.	71	0	0
Do. Electro, Feb.	77	12	6
Solid drawn tubes		15½d.	
Brazed tubes		15½d.	
Wire		12d.	
Yellow metal rods		9d.	
Do. 4x4 Squares		11d.	
Do. 4x3 Sheets		11d.	

BRASS.

Solid drawn tubes	13¾d.
Brazed tubes	16½d
Rods	12⅞d.
Sheets to 10 w.g.	12½ d.
Wire	12¾d.
Rolled metal	12d.

TIN.

	£	s.	d.
Standard cash	157	0	0
Three Months	160	0	0
English	176	0	0
Bars	158	0	0
Chinese	152	10	0
Straits	167	10	0
Australian	166	0	0
Eastern	160	10	0
Banca	174	10	0
Off. aver., cash, Feb.	166	9	1½
Do. 3 mths., Feb	170	16	3
Do. Sttlment., Feb.	166	6	6
Aver. spot, Feb.	166	5	3

SPELTER.

	£	s.	d.
Ordinary	26	15	0
Remelted	22	10	0
Hard	19	10	0
Electro 99.9	34	0	0
English	29	0	0
India	23	0	0
Prime Western	27	0	0
Zinc dust	60	0	0
Zinc ashes	6	5	0
Off. aver., Feb.	25	5	5¼
Aver., spot, Feb.	22	17	0

LEAD.

	£	s.	d.
Soft foreign ppt	19	0	0
English	20	10	0
Off. average, Feb.	21	0	0
Average spot, Feb.	20	13	7½

ZINC SHEETS.

	£	s.	d.
Zinc sheets, spot	36	0	0
Do. V.M. ex. whf	37	0	0
Do. ppt., f.o.b., N.Y.		—	
Dutch	36	0	0
Boiler plates	34	0	0
Battery plates	33	10	0

ANTIMONY.

	£	s.	d.
English regulus	37	5	0
Special brands	42	0	0
Chinese	23	10	0
Crude	19	5	0

QUICKSILVER.

	£	s.	d.
Quicksilver	12	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	£18 0 0
75%	£26 10 0
Ferro-vanadium—	
35/40%	25/- lb. va,
Ferro-molybdenum—	
70/80%	8/- lb. mo.
Ferro-titanium—	
23/25%, carbonless	1/6 lb.
Ferro-phosphorus, 20/23%	£34
Ferro-tungsten—	
80/85%, carbon free	1/10 lb.
Tungsten metal powder—	
98/99%	3/- lb.
Ferro-chrome—	
4/6% car.	£37 10
6/8% car.	£37
8/10% car.	£36 10
Ferro-chrome—	
Max. 2% car.	£84
Max. 1% car.	£100
Max. 0.75% car.	£116
65/75%, carbonless	3/- lb.
Nickel—99·8%, cubes or pellets	£200
Cobalt metal—97%	20/- lb.
Aluminium—98/99%	£150
Metallic Chromium—	
98/99%	6/6 lb.
Ferro-manganese—	
76/80%, loose	£25
76/80%, packed	£26
76/80%, export	£22 10
Metallic manganese—	
98/99%, carbonless	3/1 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	3	2
Finished bars, 18% tungsten	4	0
Scrap pieces		5d.
Turnings and swarf		3d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive 4d. lb.

Rounds and squares under ½ in. to ¼ in. 3d. lb.

Flats under 1 in. by ⅜ in. to ⅛ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.

Bevels of approved sizes and sections 6d. lb.

If in coils 3d. lb.

Packing 4s. cwt

Bars cut to length 10% extra

Scrap from high-speed tool steel—

Scrap pieces 5d.

Turnings and swarf 3d.

Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—£ s. d.	£	s.	d.
Heavy Steel	4	0	0
Bundled steel & shearings	4	0	0
Mixed iron & steel	4	10	0
Heavy cast iron	5	10	0
Good machinery for foundries	7	10	0
Cleveland—			
Heavy steel	3	5	0
Steel turnings	2	10	0
Cast-iron borings	2	10	0
Heavy wrought iron piling	5	15	0
Bundling scrap	5	5	0
Cast-iron scrap	7	0	0
Lancashire—			
Cast iron scrap	7	10	0
Heavy wrought	5	0	0
Steel turnings	2	15	0
London—			
Copper (clean)	53	0	0
Brass (clean)	32	0	0
Lead (less usual draft)	13	0	0
Tea lead	11	0	0
Zinc	12	0	0
New aluminium cuttings	70	0	0
Brazier copper	41	0	0
Gun metal	47	0	0
Hollow pewter	120	0	0
Shaped black pewter	75	0	0

PIG-IRON.

N.-E. Coast—	
Foundry No. 1	155/-
Foundry No. 3	150/-
Forge No. 4	149/-
Mottled	147/6
Hematite No. 1	182/6
Hematite M/Nos.	180/-
Midlands—	
Staffs. common	155/-
,, part-mine forge	170/-
,, ,, foundry	180/-
,, Cold blast	360/-
,, basic	145/-
Northants forge	150/-
,, foundry No. 3	170/-
,, basic	150/-
Derbyshire forge	170/-
,, foundry No. 3	175/-
,, basic	170/-
Scotland—	
Foundry No. 1	180/-
,, No. 3	175/-
Hematite M/Nos.	192/6
Sheffield (d/d district)—	
Derby forge	175/-
,, foundry No. 3	180/-
,, basic	175/-
Lincs. forge	190/-
,, foundry No. 3	195/-
,, basic	162/6
E.C. hematite	193/-
W.C. hematite	196/-
All d/d in the district.	
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, foundry No. 3	190/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	202/6
,, foundry No. 3	207/6
Summerlee foundry	218/-
Glengarnock foundry	218/-
Gartsherrie foundry	218/-
Monkland foundry	218/-

FINISHED IRON & STEEL.

Iron—	£	s.	£	s.	d.
Bars (cro'n)	20	0	24	10	0
Angles	20	10	25	0	0
Tees to 3 united ins.	21	0	25	10	0
Nut and bolt			22	0	0
Hoops			23	0	0
Marked bars (Staffs.)			27	10	0
Gas strip			26	0	0
Bolts and nuts, ¾ in. × 4 in.			45	0	0
Steel—					
Ship plates			21	0	0
Boiler plates			27	10	0
Chequer plates			22	0	0
Angles			19	10	0
Tees			20	10	0
Channels			19	10	0
Joists			19	0	0
Rounds, ½ in.–3-in.			19	0	0
Rounds, 3 in.–5½ in.			18	0	0
Flats, 5 in.–8 in.			18	10	0
Flats over 8 in.			18	0	0
Rails, heavy			18	0	0
Fishplates			23	0	0
Hoops			20	0	0
Black sheets, 24 g.			23	0	0
Galv. cor. sheets, 24 g.			24	0	0
Galv. fencing wire, 8 g. plain			30	0	0
Rivets, ¾ in. dia			32	0	0
Billets, soft			13	10	0
Billets, hard			14	10	0
Sheet and tin bars			14	10	0

PHOSPHOR BRONZE.

ROLLED.	Per lb. s.	d.
½ in. to 1 in. wide	1	11½
1 in. to 1½ in. wide	1	11½
1½ in. to 2 in. wide	1	9½

STRIPS.	s.	d.
2 in. to 6 in. to 26 S.W.G.	1	9½
6 in. to 12 in. to 26 S.W.G.	1	9½

SHEETS.	s.	d.
12 in. to 18 in. to 24 S.W.G.	1	9½
18 in. to 24 in. to 24 S.W.G.	1	10½
24 in. to 30 in. to 20 S.W.G.	1	11½
30 in. to 36 in. to 16 S.W.G.	1	11½
36 in. to 42 in. to 16 S.W.G.	2	0½

EXTRAS.

FOR GAUGE: Any width up to 36 in. wide, ¼d. per lb. per thinner gauge.

DRAWN RODS.	s.	d.
⅛ in. to ⅜ in. dia. in random lengths; 5/16 in. to 1½ in. dia. in random lengths	1	10
Over 1½ in. to 1⅝ in.	1	10
Tubes—basis price	1	11¾

Delivery 2 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON, LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	1/3 to 1/9
Rolled—	
To 9 in. wide	1/10½ to 2/4½
To 12 in. wide	1/11 to 2/5
To 15 in. wide	2/– to 2/6
To 18 in. wide	2/1 to 2/7
To 21 in. wide	2/2 to 2/8
To 24 in. wide	2/3 to 2/9
Ingots for spoons and forks	1/3 to 1/9
Ingots rolled to spoon size	1/6 to 2/–
Wire round—	
3/0 to 10. G.	2/1 to 2/8

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	30.00
No. 2 foundry Valley	26.50
No. 2 foundry, Birm.	27.50
Basic	26.96
Bessemer	28.96
Malleable	28.96
Grey forge	27.96
Ferro-manganese 80 % delievred	90.00
Bess. rails, h'y, at mill	45.00
O.-h. rails, h'y, at mill	47.00
Bess. billets	38.50
O.-h. billets	38.50
O.-h. sheet bars	42.00
Wire rods	52.00
	Cents.
Iron bars, Phila.	2.50
Steel bars	2.00
Tank plates	2.10
Beams, etc.	2.10
Skelp, grooved steel	2.35
Skelp, sheared steel	2.25
Steel hoops	2.80
Sheets, black, No. 28	4.00
Sheets, galv., No. 28	5.25
Sheets, blue an'l'd, 9&10	3.20
Wire nails	3.10
Plain wire	3.00
Barbed wire, galv.	3.85
Tinplate, 100-lb. box	$7.00

COKE.

Welsh foundry	72/6
,, furnace	57/6
Durham & North foundry	70/-
,, furnace	54/6
Other Districts, foundry	77/9
,, furnace	45/-

SWEDISH IRON.

	£ s. d.
Bars, hammered basis sizes ..	Basis price.
Rolled Ordinary—Assortment ..	31 0 0 to 38 0 0
Nail Rods—Square, round and flats ..	
Keg Steel } about Faggot Steel } £50	Prices nominal.
Blooms—Single welded ..	£20 to £25
Billets—Single and double welded ..	£22 to £27
Pig-Iron—Grey, white or mottled ..	£15 to £20

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 2 in.	Over 2 in.
Gas ..	−10%	−15%
Water .. net		+ 6¼%
Steam ..	+11¼%	+ 3⅛%

REFRACTORIES.

	£ s. d.
Magnesite bricks, 2½ in., d/d	130 0 0
Do. 3 in., d/d	156 0 0
Common firebricks, 2½ in., d/d	10 0 0
Do. 3 in., d/d	12 0 0
Scotch firebricks, 2½ in., f.o.r.	12 15 0
Do. 3 in., f.o.r.	15 7 6
Sheffield quality, 2½ in., f.o.r.	11 0 0
Do. 3 in., f.o.r.	13 5 0
Silica bricks (ord.), 2½ in., f.o.r.	14 18 6
Do. 3 in., f.o.r.	17 18 6

All per 1,000 bricks.

Basic Dolomite ..	3	18	0
Dead burnt magnesite (peas and powder), d/d ..	22	10	0
Ground fireclay	1 10 0 to 2	0	0
Ganister	1 10 0 to 1	12	6

TINPLATES.

I.C. Cokes, 20×14, box	27/-
,, 28×20, ,,	53/-
,, 20×10, ,,	38/-
,, 18¾×14, ,,	30/-
Terneplates, 28×20, ,,	55/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.		
Mar. 9	65 10 0	dec.	10/-
,, 10	65 17 6	inc.	7/6
,, 11	66 15 0	inc.	17/6
,, 14	66 2 6	dec.	12/6
,, 15	67 0 0	inc.	17/6

Standard Tin (cash).

Mar. 9	148 0 0	dec.	55/-
,, 10	149 10 0	inc.	30/-
,, 11	155 10 0	,,	120/-
,, 14	159 10 0	inc.	80/-
,, 15	157 0 0	dec.	50/-

Zinc Sheets (spot).

Mar. 9	36 0 0	No change
,, 10	36 0 0	No change
,, 11	36 0 0	No change
,, 14	36 0 0	No change
,, 15	36 0 0	No change

Spelter (ordinary).

Mar. 9	26 15 0	inc.	10/-
,, 10	26 0 0	dec.	15/-
,, 11	26 5 0	inc.	5/-
,, 14	26 15 0	inc.	10/-
,, 15	26 15 0	No change	

Lead (English).

Mar. 9	19 10 0	dec.	10/-
,, 10	20 10 0	inc.	20/-
,, 11	20 0 0	dec.	10/-
,, 14	20 10 0	inc.	10/-
,, 15	20 10 0	No change	

SHROPSHIRE IRON Co., Ltd.

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Hadley, Shropshire.

Telegrams:—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

London: 10, Bush Lane, Cannon St., E.C.4.

Telephone:—
11 Wellington, Salop.
5959 Central.

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To all Specifications.

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BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, Franco-British Grand Prix (Highest Award) 1908.

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Delivered F.O.B. Liverpool.
BARS, ANGLES, TEES and PLATES.

HOOPS delivered F.O.B. Liverpool.

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R.D. ✿

RAVENSDALE (Best)

MILD STEEL (up to 2in. wide)
Marked
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Telephone: 7860 AVENUE (3 lines.
Head Office:
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LIMPET

PIG IRON.

Scotch, Middlesbro,' Hematite, Basic, Specials, &c., &c.

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COPPER — ANTIMONY—MANGANESE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE,
MIDDLESBROUGH.

93, HOPE STREET,
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SITUATIONS VACANT AND WANTED.

HEAD FOREMAN wanted for large Bronze and Brass Foundry. Applicants must be first-class men on reverbatory furnaces, melting high-class bronzes and gunmetals for propellers and ships castings to Admiralty requirements; knowledge of machine moulding essential.—State age, experience, and wages to Box 698, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

HEAD CLERK Wanted for Brass Foundry 30 miles from London, experienced in accounts, costing and wages. Preference given to one who can read drawings and has been engaged in a similar position. Good address and appearance essential. —Write in first instance giving full details of experience, age, salary required, and when disengaged, Box 124, Messrs. The Industrial Publicity Service, Limited, 4-7, Red Lion Court, Fleet Street, E.C.4.

MACHINERY.

TURN TO THE B.W.S. ANNOUNCEMENT, PAGE 12.

FOR SALE, One No. 2 Roots Blower, belt-driven, in good working order. Makers, Thwaites Bros.—Apply, George Crossley, Limited, Albion Iron Works, Cleckheaton.

FOR SALE.

6-WHEEL COUPLED SADDLE TANK LOCOMOTIVE (Manning Wardle), with inside cvls., 12 in. diam. x 18 in. stroke; 4 ft. 8½ in. gauge; copper firebox; steel tubes; 140 lbs. steam W.P.; thoroughly overhauled, and ready for immediate work.

DITTO (Manning Wardle), with inside cyls. 12 in. x 18 in.; 4 ft. 8½ in. gauge; steel firebox; brass tubes; 140 lbs. steam W.P.; thoroughly overhauled, and ready for immediate work.

4-WHEEL COUPLED SADDLE TANK LOCOMOTIVE (Manning Wardle), with outside cyls. 8 in. x 14 in.; 4 ft. 8½ in. gauge; 140 lbs. steam W.P.

7-TON "WHITAKER" CRANE-TYPE STEAM NAVVY, with 30-ft. steel fixed jib; 4 ft. 8½ in. gauge, also broad gauge wheels; boiler 9 ft. x 4 ft., for 90 lbs. steam W.P.; ready for immediate work.

10-TON TOWER-TYPE STEAM NAVVY (Ruston Proctor), with bucket 1½ cub. yds. capacity; gauges 4ft. 8½ in. and 11 ft.; boiler 8 ft. 6 in. high x 3 ft 6 in. diam., for 80 lbs. steam W.P.

5-TON HAND-POWER FOUNDRY JIB CRANE. about 24-ft. radius; constructed mostly of built-up channels.

HAND DERRICK CRANES, 3, 2½, 2, 1½, and ½-ton sizes, all ready for immediate despatch.

5-TON STEAM DERRICK CRANE (Taylor & Hubbard), with about 50-ft. split timber jib; boiler 8 ft. 6 in. x 3 ft. 6 in., for 80 lbs. steam W.P.; two speeds for hoisting.

CATALOGUE OF STOCK MACHINERY, 5-6,000 LOTS, FREE ON APPLICATION. INSPECTION INVITED.

THOS. W. WARD, Ltd.,
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FOR SALE.—"Locomotive" Gauge, 2 ft. 10 in., wheel base 3 ft. 6 in., bore 6 in., stroke 10 in., saddle back, copper firebox, brass tubes. Also wagons and rails.—Ashton & Holmes Ltd., Macclesfield.

WANTED all users of METALLIC CEMENT to buy our PEERLESS brand, which produces "Artificial Iron" 10 lb. tin 10s., free delivered.—William Olsen, Ltd., Cogan Street, Hull.

PATTERNS and CASTINGS SUPPLIED WHICH GIVE SATISFACTION. Inquiries solicited Quotations by return of post or telephone. You can secure good-class work, reasonable prices, and promptitude in delivery by placing your orders with Videx Pattern Works and Foundry, Huntsworth Mews, Upper Baker Street, London, N.W.1. (Telephone, Paddington 364).

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SAND for Moulding and other purposes. Free sample sent. Price, f.o.r. Canterbury, 10s. per ton.—Sand Company, Canterbury.

MISCELLANEOUS—*Contd.*

NON-FERROUS Foundry Business for Disposal. Four pit furnaces and excellent equipment, good shops and ample room for expansion. 30 minutes from Marble Arch. Low rents. Purchase money would include the benefit of current contracts.—Box 712, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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ENQUIRIES SOLICITED FOR CASTINGS IN IRON, machined or unmachined, up to 5 cwt. Complete Machines built throughout to specification. singly or in quantity. Jig and Tool Work a speciality.—C. S. Peatfield, Limited, Market Rasen, Lincs.

WE Specialise in FANS and FAN WORK for Foundries. H.P. Fans and Blowers for Smiths' Hearths, Cupolas, Oil and Gas-fired Furnaces, Dust Extraction Fans for Fettling Shop and Sand Blast, Ventilating Fans for Fumes, etc. Worm-geared Pulley Blocks, 10 cwt. to 10 tons.—Progressive Engineering Company, Limited, Leicester.

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